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GEORGE STEPHENSON, THE FATHER OF RAILWAYS.

HOWEVER humble the origin of many of England's greatest men, they have invariably had mothers of remarkable character or of devoted earnestness in promoting the welfare of their sons. The father and mother of George Stephenson were of lowly estate; but Mrs. Stephenson was always spoken of by those who knew her as "a canny body," which in the North means all that is nice and clever and good and reliable. She was Mabel Carr, a native of Ovingham, and the daughter of Robert Carr, a dyer. The Carrs were people of substance, and their family tombstone is seen in the old churchyard. Mabel's husband, Robert, was an ordinary working man, and they lived at Wylam, about eight miles from Newcastle, in a cottage called High-street House, where George was born, on June 9, 1781. The incidents of his early days, which one sorrows over while reading Smiles' touching narrative of his life, studied from the ultimate standpoint of his success, were absolutely necessary to the building up of the man who was fated to build up our railway system. At the age of eight the boy began to work. His parents were too poor to send him to school. He herded cattle for a widow, who had a little farm near Wylan. His wages were a shilling a week—twopence a day. His life in the open air stimulated his love of birds and domestic animals. In addition to the duties of herdsman, he had to shut the gates of the tramroad when the wagons had passed, to keep the cows from straying upon the track. There were little water streams here and there. Upon their miniature banks he and a companion named Thirlwall erected tiny mills. From this they rose to a higher standard of amusement. They modeled engines out of clay, and converted hemlock stems into imaginary steam-pipes. Then they made corves, or small wagons, out of corks, and drew them about by the mechanism of a miniature winding-machine. Some of the pitmen passing to and fro smashed the whole of the apparatus. Combined with courage and a certain softness of disposition, there is in the lower classes of the pit villages a great deal of brutality and coarse spitefulness toward the young. Just as Canova, when a child, modeled statues, George Stephenson modeled engines and tramways and winding machines; and many a year later his herculean works were for a time only regarded as toys of little more use than the mechanical playthings of his infancy.

Born June 9, 1781. GEORGE STEPHENSON. **Died August 12, 1848.**

AFTER THE PAINTING BY JOHN LUCAS.

From tending cows he was promoted to hoeing turnips at fourpence a day; from turnips he was advanced to the work he most desired—he was employed at the adjacent pit to drive the "gin" horse. At fourteen he obtained the position of assistant fireman, under his father, at a shilling a day. When he was promoted to be engineer he was seventeen years of age, and he could neither read nor write; but his perceptive faculties were keen and active, and he was an earnest student of practical mechanics. He used continually to take his engine all to pieces and examine its parts and action. He mastered it and loved it, spending most of his leisure in studying its powers and keeping it in perfect working order.

At eighteen George Stephenson did not even know his alphabet, though he had learned the A B C of the Newburn pumping engine. He had often sat listening to the newspaper wonders divulged at the engine fire by men who could read. It now dawned upon him that the art of reading was necessary to his advancement as a skilled mechanic. To discover what he ought to do was to do it. He went to a night school, kept by a Scotchman, one Andrew Robertson. A grown man in stature and experience, he sat down to make pothooks. An engine man, with a vague ambition to rise still higher, he went to school to learn the infantile mysteries of the first lessons in spelling. He learned with avidity, for he studied with a hungry desire to learn. When he stood upon the threshold of mathematics, in his first arithmetical sums, he was a young giant in his progress. He conquered "figures" in a daily advance that eclipsed all his competitors. He was "summing" at the night school, "summing" in his engine house, "summing" at all hours; and yet neither his engine nor his birds were neglected. He made Time bend to his will. The beerhouse and the tavern had no attractions for him. He was not a teetotaler, but he was strictly sober, and he wished to become a well to-do and skillful workman—to win the confidence of his employers, and have the respect of his neighbors. The coppers paid to Andrew Robertson were an investment in this direction; and, although he worked with the ardor of a great ambition, it is pretty evident that at this period his desires did not go beyond local success and a competent livelihood. In order to add to his income he mended shoes. His wages at the Dolly Pit, where he was engineman, were one pound a week, and the first guinea he saved was out of his amateur shoe work. He could turn his hand to anything. He mended clocks as well as shoes, and "doctored" engines also; and he could "throw the hammer" in the local games further than anybody. Among the shoes that he mended were those of Fanny Henderson, who was the domestic servant in a little farmhouse where he lodged. He carried the shoes about in his pocket, the talisman of his love.

On November 28, 1802, George Stephenson married Fanny Henderson at Newburn church. After the ceremony he and his wife went to pay their respects to George's father and mother at Jolly's Close. Old Stephenson was still an engine fireman. From Jolly's Close George took his wife home to Wellington Quay, where he was employed as brakesman. He had saved enough money to furnish a cottage in a very humble manner, and thither he and his bride journeyed in the pretty old fashion of saddle and pillion. Robert Gray and Anne Henderson were their companions on this occasion. George and Fanny were on one horse, Fanny with her arms round George's waist, and Robert and Anne followed, similarly mounted. They rode for fifteen miles. The young married couple lived a quiet, happy, homely life. George spent a good deal of time in experiments on perpetual motion. On October 16th, 1803, his son Robert was born. In 1808 he and two other brakesmen, Robert Wedderburn and George Dodds, took a small contract for managing the engines at the West Moor Pit. George lived with great economy, and eked out his regular earnings by all kinds of extra work, in order that he might send his son Robert to school. He mended the local clocks, made shoe lasts for the shoemakers, mended boots, and even cut out the pitmen's clothes for their wives to make up. He noticed defects in the pit ropes and the construction of the winding apparatus. He suggested certain alterations, and, being allowed to make them, saved thereby for the proprietors both money and labor.

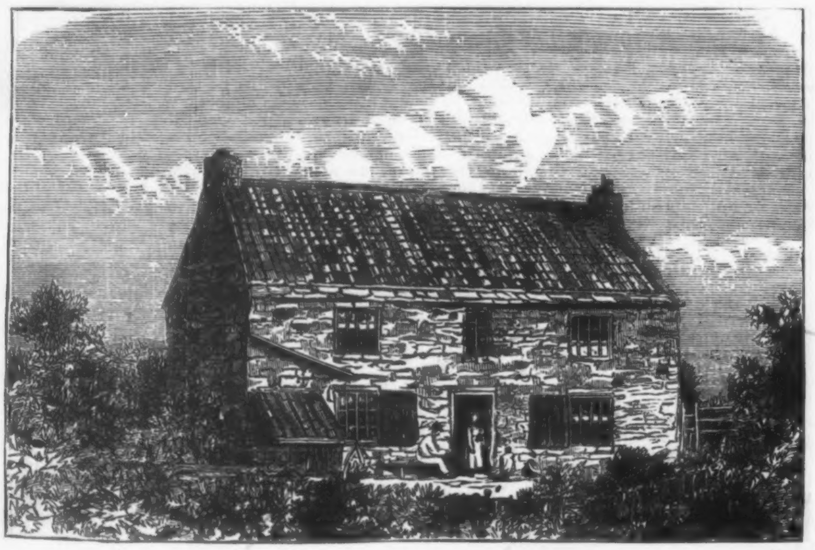
George Stephenson's first great local triumph was at the village of Killingworth, where the High Pit was being pumped by an atmospheric or Newcomen engine. The water could not be kept under. A whole year's pumping had done little or no good, and the engine had come to be regarded as a complete failure. One Saturday afternoon George went to look at the work. He was asked by a man employed at the pit what he made of it. "In a week I could send you to the bottom," said George in reply. Although Stephenson was then only a brakesman, he was regarded as a practical and ingenious man, and the conversation in question was reported to Mr. Ralph Dodds, the head viewer, who hunted George up and told him if he really could pump the pit dry he would "make him a man for life." George undertook the job, on one condition; the workmen, he said, "must either be all Whigs or all Tories." George knew well enough that the regular men employed at the pit who had failed during the last twelve months to make any impression upon the flood would hardly rejoice in his success; he insisted, therefore, upon employing his own laborers and thus securing to himself a fair trial. He took the engine to pieces, enlarged the injection cap, packed the cylinder at the bottom, made other alterations which occupied four days, and within the week the pit was dry and the men at work. This gave the self-taught engineer a wide reputation.

The first tramway was made in 1800, by Benjamin Outram, a native of Derbyshire, who used stone props instead of timber in supporting the junction of the rails. Roads constructed on this fashion were named after him; they were known as "Outram roads," and thus the corruption to the present definition, tramroads. Some speculative applications of steam were made to the propulsion of wheeled carriages—an idea by no means new, even at that time. Nothing, however, of any importance was done until 1802, when Trevithick invented a steam locomotive to run upon common roads.

Mr. Stephenson examined this engine made by Trevithick, and his mind continually brooded over the subject. The locomotive, in a limping and profitless way, may be said already to have existed when George Stephenson made his first drawings; but it only existed in the colliery districts, where it laboriously hauled coals at two or three miles an hour, and at an expense considerably beyond that of horseflesh. One of his greatest discoveries in connection with the locomotive engine was the utilization of the jets of exhaust steam to create a draught for the furnace, thus doubling the power of his first locomotive, and leading him ultimately to the invention of his multitubular boiler. In 1815 he had made an engine which was notable for the following improvements on all other efforts—namely, "simple and direct communication between the cylinder and the wheels rolling upon the rails; joint adhesion of all the wheels attained by the use of horizontal connecting rods; and, finally, a beautiful method of exhausting the combustion of the fuel by employing the waste steam, which had formerly been allowed uselessly to escape into the air."

It was about this period that he invented the safety lamp, stimulated thereto by the frequent fatal explosions at the local mines. There is nothing more dramatic in biographical history than the way in which he tested its power at the risk of his life. Accompanied at midnight by his friend

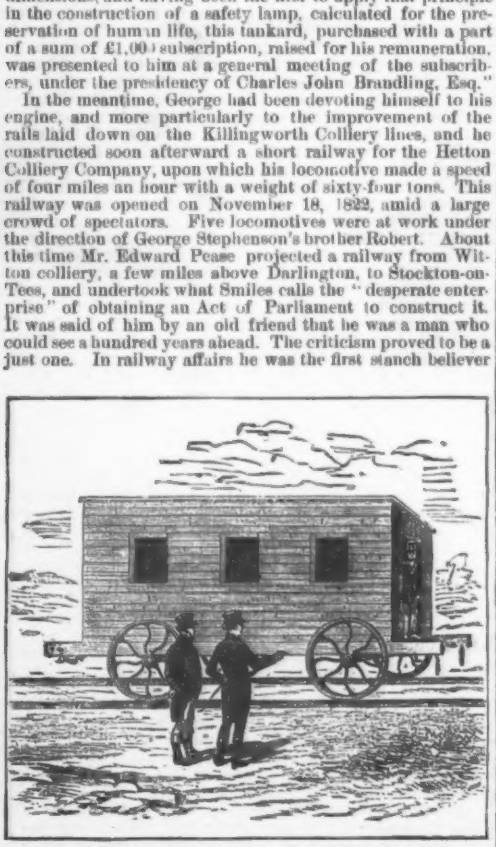
Mr. Nicholas Wood and his son Robert, he descended the pit, and, leaving them at a safe distance, entered a heading where there was a blower, and courageously held up his lamp in the midst of the gas. Certain and instant death must have followed had not his invention been complete. It is not necessary to dwell upon the controversy which followed in regard to the first conception and construction of the safety lamp. Sir Humphry Davy was almost simultaneously occupied with a similar idea, but it was afterward sufficiently established by dates and evidence that the two inventions were distinct and separate events, with this difference in favor of George Stephenson, that he had made and tested his prior to the production of the "Davy," and that when this lamp of the great scientist was sent down into the north the local pitmen were already using the "Geordie," which even to this day is regarded as the best and most reliable lamp of the two. In 1818 George received a testimonial of one thousand pounds at a public dinner given at



STREET HOUSE, WYLAM, THE BIRTHPLACE OF GEORGE STEPHENSON.

Newcastle-on-Tyne, with a piece of plate bearing an inscription, founded upon conclusive evidence taken before the Literary and Philosophical Society, proclaiming that, "Mr. George Stephenson having discovered the fact that inflamed fire-damp will not pass through tubes and apertures of small dimensions, and having been the first to apply that principle in the construction of a safety lamp, calculated for the preservation of human life, this tankard, purchased with a part of a sum of £1,000 subscription, raised for his remuneration, was presented to him at a general meeting of the subscribers, under the presidency of Charles John Brandling, Esq."

In the meantime, George had been devoting himself to his engine, and more particularly to the improvement of the rails laid down on the Killingworth Colliery lines, and he constructed soon afterward a short railway for the Hetton Colliery Company, upon which his locomotive made a speed of four miles an hour with a weight of sixty-four tons. This railway was opened on November 18, 1822, amid a large crowd of spectators. Five locomotives were at work under the direction of George Stephenson's brother Robert. About this time Mr. Edward Pease projected a railway from Witton colliery, a few miles above Darlington, to Stockton-on-Tees, and undertook what Smiles calls the "desperate enterprise" of obtaining an Act of Parliament to construct it. It was said of him by an old friend that he was a man who could see a hundred years ahead. The criticism proved to be a just one. In railway affairs he was the first stanch believer



THE EXPERIMENT COACH, COMMON CAR.

in George Stephenson, and they became eventually fast and earnest friends. The Stockton and Darlington Railway Bill was a Parliamentary battle for some years; thrown out at first, but finally accepted. It was originally only intended to be a tramway worked by horse power, and as such it was surveyed, and its construction commenced by Mr. Stephenson. During the progress of the works the engineer suggested frequently that he should be allowed to work the line with locomotives, and finally Mr. Pease and his friends were prevailed upon to consent. The railway was opened for traffic on September 27, 1825, George Stephenson himself driving the first locomotive, the engine drawing thirty-eight vehicles, upon which there were four hundred and fifty passengers and some ninety tons of merchandise. The highest speed attained was twelve miles an hour; the average, four to six. The railway was projected for the purpose of opening up the Stockton and Darlington coal district.

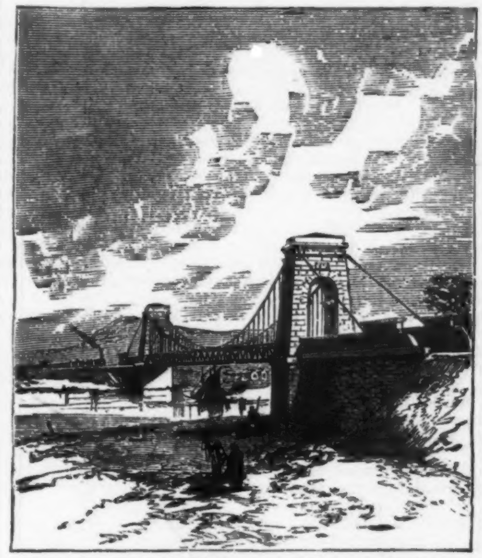
Within a few years of Mr. Lambton's parliamentary "triumph" the annual shipment of coal carried by the Stockton and Darlington Railway to Stockton and Middlesborough exceeded 500,000 tons. What was almost equally surprising to the enterprising constructors of the line, although they had looked for a reasonable passenger traffic, was the rapid increase in the number of persons who consented to risk their lives in the "railway coach" which the directors had authorized Mr. Stephenson to build. This first railway carriage, very much like a large bathing machine, was called "The Experiment." It was, however, not permitted at the outset to propel it by a locomotive; it was drawn by one horse, and made a journey daily each way between Stockton and Darlington, the distance of twelve miles being accomplished in about two hours. The fare was a shilling; there was no distinction of class, and each passenger was allowed fourteen pounds of luggage. The coach was not worked by the company, but was let to Messrs. Pickersgill & Harland, railway carriers, under arrangement as to the payment of tolls for using the line, rent of "booking cabins," etc. "The Experiment" proved so great a success that other persons rented coaches and ran them upon the line. It was only a single line with four sidings in the mile, and when the two coaches met there arose the difficult question of which should go back. It had already been understood that light wagons should always give way to loaded ones, and that as to passenger-coaches, they should have preference over coals; but, in regard to the competition between coaches, the drivers and the passengers had to quarrel that out among themselves. Eventually a compromise was effected by the erection of a post midway between sidings, and the establishment of a rule that the driver who had passed the pillar should go on, and the man coming the other way go back. Mr. Clephan, a north-country writer, quoted by Mr. Smiles, mentions that a man named Dixon, the driver of one of these coaches, was the inventor of carriage-lighting on railways. "On dark winter nights, having compassion on his passengers, he would buy a penny

THE ROCKET.

candle and place it, lighted, among them on the table of 'The Experiment;' the first railway-coach (which, by-the-way, ended its days at Shildon as a railway cabin, being also the first coach on the rail, first, second, and third class jammed all into one) that indulged its customers with light in darkness." The Stockton and Darlington Railway, projected by Edward Pease, and carried out by George Stephenson, was a great success; and the engineer, in his later days of prosperity, did not forget his early friend, who was very proud of exhibiting a handsome gold watch bearing the following inscription: "Esteem and gratitude, from George Stephenson to Edward Pease."

The success of the Stockton and Darlington Railway and the chronic congestion of transport between Liverpool and Manchester stimulated the manufacturers of South Lancashire to project a tramroad between the famous northern port and Cottonopolis. It took longer to convey cargoes of cotton from Liverpool to Manchester than it had taken to bring them across the Atlantic.

At first, even to the enterprising men of the North, the tramroad seemed a wild kind of scheme; but at length surveys were made with a view to obtaining an Act of Parliament for the purpose. So inimical to the general welfare was the iron road regarded that the surveyors and their assistants were attacked by mobs of people, and noted bruisers had to be engaged to carry the theodolite, an instrument which appeared to excite the ferocity of the natives to its highest pitch. These obstructions were common and frequent, even before the advent of the locomotive—how serious they were afterwards is a matter of history. The construction of railways was not only opposed by the ignorant people in country districts with pitchforks, with guns, and with stones, but they excited the most determined opposition of great landowners, of leading men in cities, of public bodies, and of Parliament itself. No improvement in the



THE FIRST RAILWAY SUSPENSION BRIDGE ERECTED OVER THE TEES.

social, domestic, or political economy of a people was ever carried against more persistent hostility, or with greater self-denial, energy, and perseverance on the part of the projector and his handful of friends and adherents. Mr. Sandars, an influential Liverpool merchant, was among the first promoters of the Liverpool and Manchester tramway, and he held public meetings upon the subject in various parts of the district, one more particularly in the Exchange at Liverpool, another at the George Hotel at Warrington.

Finally, the work was handed over to Mr. Stephenson. A Liverpool committee, under his advice, proceeded to form a company of proprietors for the construction of a double line of railway, and in due course of time the plans were prepared. The local canal company entered against it an uncompromising hostility; and, indeed, all the navigation companies of the kingdom combined to oppose the projected Liverpool and Manchester line. The journals of the time, with few exceptions, treated the matter with ridicule, and the champions of the existing systems of transport in pamphlets and in public speeches denounced the project of carriage by steam as one of the most damaging and awful character. They declared the locomotive would poison the air, kill the birds as they flew over them, destroy the preservation of pheasants, burn up the farms and homesteads near the lines; that oats and hay would become unsalable because horses would become extinct; traveling on the highways would become impossible; country inns would be ruined; boilers would burst and kill hundreds of passengers; and, indeed, there was no peril or evil imaginable that was not predicted to attend the working of a railroad by steam. George Stephenson worked night and day at his survey, at his plans, and at the improvements in his engine, and on March 21, 1825, the Liverpool and Manchester Bill went into Committee of the House of Commons. Its opponents were backed by great wealth, and by all the legal talent that could be got together for money. Among the counsel against the bill were Mr. (afterwards Baron) Alderson, Mr.

THE EXPERIMENT, FIRST RAILWAY PASSENGER COACH, 1825.

(afterwards Baron) Parke, Mr MacDonnell, Mr. Harrison, Mr. Earle, Mr. Cullen, and others; the case for the railway being conducted by Mr. Adam, Mr. Serjeant Spankie, Mr. William Braham, and Mr. Joy. Mr. George Stephenson, many years afterwards, told his friends that his chief difficulty, during his evidence, was to keep down the rate of speed of his locomotive, for the promoters of the bill had told him that if he talked of going at a greater rate than ten miles an hour he would utterly ruin their case. "It was," said Stephenson, "not an easy task for me to keep the engine down; but it had to be done, and I did it. I was not long in the witness-box before I began to wish for a hole to creep out at. I could not find words to satisfy either the committee or myself. I was subjected to the cross-examination of eight or ten barristers, purposely, as far as possible, to bewilder me. Some member of the committee asked if I was a foreigner, and another hinted that I was mad; but I

put up with every rebuff, and went on with my plans, determined not to be put down." It is not within the compass of this article to give anything like a sketch of the proceedings before the committee. The characteristic words just quoted are sufficient to indicate the hardships endured by the chief witness and his friends. Once or twice, however, with all his humility, Stephenson broke out. Asked, for example, if something he said was not on the hypothesis that the railroad was perfect, he replied, "Yes, it is; and I mean to make it perfect." It is an old story now, but the subject of the committee may hardly be passed over without repeating it, that one of the members of the Committee put the following case: "Suppose, now, one of these engines to be going along a railroad at a rate of nine or ten miles an hour, and that a cow were to stray upon the line, and get in the way of the engine, would not that, think you, be a very awkward circumstance?" "Yes," replied Stephenson, with a smile and a twinkle of his merry eye, "very awkward indeed—for the *coo*." The insolence of the question as to whether he was a foreigner arose from Stephenson's Northumbrian accent, which he retained with very little modification to the end of his life. After many days the committee divided on the preamble of the bill, which was carried by a majority of one—37 for, 36 against. The clauses were next taken. On a division, the first, which empowered the company to make the railway, was lost by a majority of 19 to 11; the next, which empowered the company to take land, was also lost, whereupon Mr. Adam, on the part of the promoters, withdrew the bill. The defeat was in some measure promoted by the obstacles which the survey had to encounter from landowners and canal companies, thus rendering the plans sufficiently imperfect to be vulnerable under strict legal criticism.

Lord Sefton and Lord Derby were two of the greatest opponents of the bill; and in the next survey for the line the property of the former was avoided, and only a few detached fields of the latter included. The game-preserving localities were carefully ruled out of the plans, and many other objections raised to the first line were considered and avoided in the second; and in their second prospectus the company agreed not to require any clause in the Act empowering them to use the locomotive, but to submit to whatever restrictions Parliament might impose upon its use in the interest of property and the public at large. After a second hot parliamentary battle the third reading of the bill was passed by a majority of 88 to 41; and when it went up to the House of Lords it was almost unanimously accepted, the Earl of Derby and his relative the Earl of Sefton being its only opponents. It cost £27,000 to obtain the Act. Mr. George Stephenson was appointed principal engineer.

When the great works of the Liverpool and Manchester line were completed, the question arose as to how it should be worked—whether by stationary engines, by horses, or by the locomotive. Scores of projects were submitted to the directors, some from France and some from America; schemes for working with water-power, schemes for working with hydrogen, schemes for working with carbonic gas, schemes of atmospheric pressure, and every kind of fixed and locomotive power, including a greased road with cog-rails. It was urged against Stephenson's engine that smooth wheels and smooth rails could not possibly work, and the two chief engineers of the day reported in favor of fixed engines. "Not a single professional man of eminence," says Smiles, "could be found to coincide with George Stephenson in his preference for locomotive over fixed-engine power; he had scarcely a supporter, and the locomotive system seemed on the eve of being abandoned. Nevertheless, Stephenson persevered; and finally, under his persistent assurances that the locomotive would do all and more than they could possibly require, they (the directors) determined to offer a prize of £500 for the best locomotive engine which, on a certain day, should fulfill certain specified conditions in the most satisfactory manner, all they asked for in the way of speed being that ten miles an hour should be maintained." In the meantime Mr. Stephenson had established a locomotive manufactory at Newcastle-on-Tyne, which was under the chief management of his son, and several engines had already been constructed at these works. For the famous trial, and the premium of £500, four engines were entered to compete—namely, Braithwaite & Ericson's "Novelty," Mr. Timothy Hackworth's "Sanspareil," Stephenson & Company's "Rocket," and Mr. Burstall's "Perseverance." On the day fixed, Oct. 6, there was a great and distinguished crowd to see the show. Stephenson's engine stood third on the list for trial, but it was ready first, and made an experimental trip in which it ran twelve miles in fifty-three minutes. The "Novelty" was next called, and made a brief experiment; so also was the "Sanspareil." The contest, however, was postponed until the following day, in the interest of these two latter engines. The special peculiarity of the "Novelty" was that the air was driven through the fire by means of bellows, which early on the trial-day burst, and prevented the engine from performing. The boiler of the "Sanspareil" proved defective, and the trial was again postponed till the next day. In the meantime, to satisfy the crowd, however, Mr. Stephenson attached the "Rocket" to a coach containing thirty persons, and ran them about at the rate of twenty-four to thirty miles an hour to their vast delight and astonishment. On the next day the "Rocket" was duly tested, and it more than satisfied every condition, the maximum velocity which it attained being twenty-nine miles an hour, or, as Mr. Smiles says, "about three times the speed that one of the judges of the competition had declared to be the limit of possibility." The "Novelty" and the "Sanspareil" were not ready for trial until the 10th, and they both gave out in one way or another during the work they undertook. The "Perseverance" could only make a speed of from five to six miles an hour, and was withdrawn from competition. The prize was, therefore, awarded to the "Rocket;" and from this moment many of Mr. Stephenson's bitterest opponents became his best friends. The railway was opened on Sept. 15, 1830.

From this time until a few years before his death George Stephenson, assisted by his son, was occupied in carrying out our great railway system. The London and Birmingham line was in due course projected, with the two Stephensons as joint engineers. The engineering difficulties of the undertaking were enormous, notably the boring of Kilsby tunnel, one of the most remarkable and interesting works in the history of railways. The opposition of the land-owners of Northampton forced its construction upon the company. The first contractor, in face of immense falls of sand and inundations of water, abandoned the work. George Stephenson never once wavered or gave way. The tunnel was eventually made; and it is estimated that the water pumped out of it during the progress of the works would be equal to the contents of the Thames at high water between London and Woolwich. In 1835 the North Midland Railway was projected; the Act was obtained in the following year; and the line commenced by Mr. Stephenson, assisted by one of his favorite pupils, Mr. Swanwick, in 1837. Seventy-two miles and a half in length, it had two hundred bridges and seven tunnels; and it was during the construction of this magnificent railway—"far more wonderful," Mr. Smiles thinks, "than Napoleon's vaunted road over the Simplon"—that Mr. Stephenson associated himself with the collieries at Clay Cross, and eventually took up his residence at Tapton House, Chesterfield.

The famous engineer's last days were spent in a dignified and pleasant rest. He occupied much of the leisure of his retirement in superintending the cultivation of his garden at Tapton House.

Sir Robert Peel was one of his most intimate friends, and he spent many pleasant days at the famous minister's hospitable house, Drayton Manor. He was present at the opening of many of the new railways that were inaugurated in his latter days. He died on Aug. 12, 1848, and was buried in the new church (Trinity) at Chesterfield.—*Illustrated London News.*

THE GEORGE STEPHENSON CENTENARY AT NEWCASTLE.

THE celebration on Wednesday, June 8, 1881, of the hundredth anniversary of George Stephenson's birthday, took place at Newcastle-on-Tyne, according to previous arrangement.

The town was abundantly decorated for this occasion. Above 400 tall Venetian masts, covered with red cloth, and surmounted by gilt spear-heads, each supporting a trophy of flags, were ranged along the principal streets; and there was a grand show of banners and a variety of garlands, ornamental mottoes, wreaths of foliage, and floral decorations, on the fronts of the houses and shops. The Gray column, which was erected in honor of Earl Gray, the Reform Bill Minister of 1832, had affixed to its base an inscription bearing the name of George Stephenson, accompanied by those of Hedley, Blenkinsop, Trevithick, and others who preceded him in attempts to contrive the locomotive engine. The monument or statue of George Stephenson, by the sculptor Lough, in Neville street, was adorned with a tasteful arrangement of plants and flowers. The High Level Bridge, the Central Railway Station, and the Town Hall of Newcastle, were handsomely decorated with appropriate festive designs.

The town was early filled with thousands of holiday people, and with visitors from other places of Northumberland, Durham, and North Yorkshire. The first notable exhibition of the day was the procession of modern railway engines, which started from the Central Station to Street House, Wylam, George Stephenson's birthplace, shortly after eight o'clock. The engines which took part in this procession were:

1. No. 363, furnished by the North-Eastern Railway Company, built by the company at Gateshead, express passenger engine on six wheels—four wheels coupled, 7 ft. diameter; diameter of cylinders, 1 ft. 5½ in.; length of stroke, 2 ft.; E. Fletcher, engineer.

2. No. 493 (Netherby), furnished by the North British Railway Company, built by the company at Cowlair's Works; bogie passenger engine on eight wheels—four wheels coupled 6 ft. 6 in. diameter; diameter of cylinders, 1 ft. 6 in.; length of stroke, 2 ft. 2 in.; D. Drummond, engineer.

3. No. 619 (Mabel), furnished by the London and North-Western Railway Company, built by the company; standard main-line passenger engine on six wheels—four wheels coupled, 6 ft. 6 in. in diameter; diameter of cylinders, 1 ft. 5 in.; length of stroke, 2 ft.; F. W. Webb, engineer.

4. No. 1521, furnished by the Midland Railway Company; built by Messrs. Neilson & Co., Glasgow; express passenger engine on six wheels—four wheels coupled; 6 ft. 9 in. diameter; diameter of cylinders, 1 ft. 6 in.; length of stroke, 2 ft. 2 in.; S. W. Johnson, engineer.

5. No. 664, furnished by the Great Northern Railway Company; built by the company; bogie passenger engine on eight wheels—driving-wheels, 8 ft. diameter; diameter of cylinders, 1 ft. 6 in; length of stroke, 2 ft. 4 in.; P. Stirling, engineer.

6. No. 653, furnished by the Lancashire and Yorkshire Railway Company; built by Messrs. Sharp, Stewart, & Co., Manchester; bogie passenger engine on eight wheels—four wheels coupled, 6 ft. diameter; diameter of cylinders, 1 ft. 5½ in.; length of stroke, 2 ft. 2 in.; W. B. Wright, engineer.

7. No. 1268, furnished by the North-Eastern Railway Company, built by the company at North road, Darlington; express passenger engine on six wheels—four wheels coupled, 7 ft. diameter; diameter of cylinders, 1 ft. 5 in.; length of stroke, 2 ft. 2 in.; E. Fletcher, engineer.

8. No. 329 (Stephenson), furnished by the London, Brighton, and South Coast Company, built by them at Brighton Works; express passenger engine on six wheels—driving-wheels (single), 6 ft. 6 in. diameter; diameter of cylinders, 1 ft. 5 in.; length of stroke, 2 ft., length of boiler, 10 ft. 2 in.; diameter ditto, 4 ft. 3 in.; length of fire-box, 5 ft. 8¼ in. outside; breadth of ditto, 4 ft. 1 in. ditto; W. Stroudley, engineer.

9. No. 1,000, furnished by North-Eastern Railway Company, built by the company at Gateshead; bogie tank passenger engine on eight wheels—four wheels coupled, 5 ft. 6 in. diameter; diameter of cylinders, 1 ft. 5 in.; length of stroke, 1 ft. 10 in.; E. Fletcher, engineer.

10. No. 313, furnished by Lancashire and Yorkshire Company, built by same company; goods engine on six wheels, all coupled, 4 ft. 6 in. diameter; diameter of cylinders, 1 ft. 5½ in.; length of stroke, 2 ft. 2 in.; W. B. Wright, engineer.

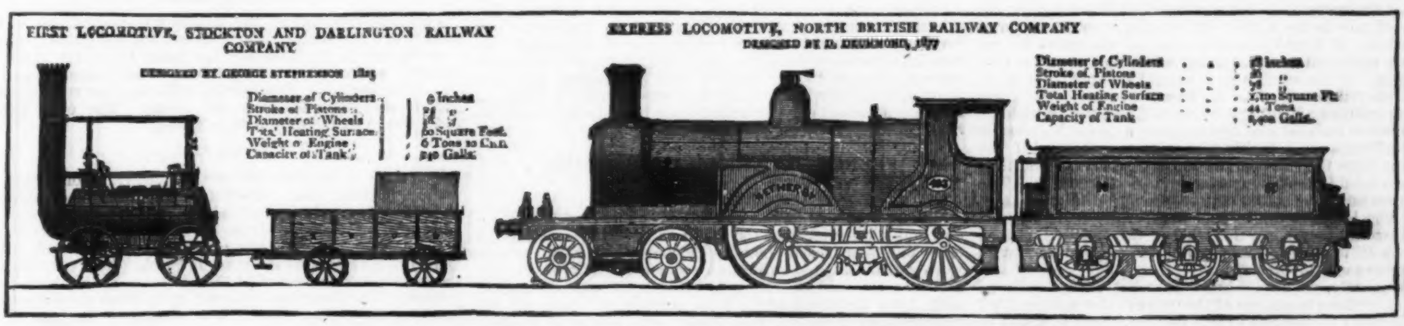
11. No. 1451, furnished by Midland Railway Company, built by Messrs. R. Stephenson & Co., Newcastle; main line goods engine on six wheels, all coupled, 5 ft 2½ in. diameter; diameter of cylinders, 1 ft. 5½ in.; length of stroke, 2 ft. 2 in.; S. W. Johnson, engineer.

12. No. 626, furnished by North-Eastern Railway Company; built by North-Eastern Railway Company, North road, Darlington; goods engine on six wheels, all coupled, 5 ft. 6 in. diameter; diameter of cylinders, 1 ft. 5 in.; length of stroke, 2 ft. 2 in.; E. Fletcher, engineer.

13. No. 484, furnished by the North-Eastern Railway Company, built by the company at Gateshead; express goods engine on six wheels all coupled, 3 ft. diameter; diameter of cylinders, 1 ft. 5 in.; length of stroke, 2 ft.; E. Fletcher, engineer.

14. No. 247, furnished by Lancashire and Yorkshire Railway Company, built by Messrs. Ritson & Co., Leeds; goods tank engine on eight wheels, six wheels coupled, 5 ft. 1 in. diameter; diameter of cylinders, 1 ft. 5½ in. length of stroke, 2 ft. 2 in.; W. B. Wright, engineer.

15. No. 1435, furnished by North-Eastern Railway Company, built by R. and W. Hawthorn, Newcastle; bogie passenger engine on eight wheels, four wheels coupled, 5 ft. diameter; diameter of cylinders, 1 ft. 4 in.; length of stroke, 1 ft. 10 in; E. Fletcher, engineer.



"THEN AND NOW."—THE EARLIEST AND LATEST LOCOMOTIVE ENGINES.

16. Locomotive furnished by London and North-Western Railway Company, built by Grand Junction Railway Company, 1842; passenger engine; outside cylinders, 1 ft. 3¼ in. diameter; stroke, 1 ft. 10 in.; single driving wheels, 6 ft. diameter; leading and trailing wheels, 3 ft. 6 in. diameter; this engine has a six-wheel tender; specially constructed with tank under couple floor; F. W. Webb, engineer.

The procession was witnessed by large crowds of people, who cheered it along the entire route. The engines were linked together and ran thus on to Wylam, eight miles from the town. They were there placed for exhibition together with the five old original locomotives, which were the Killingworth engine (the first that Stephenson ever made), the Hetton Colliery engine, the old Darlington engine, No. 1 Locomotive, from Darlington, and the "Victor" from the North-Eastern Railway. A special train followed, carrying the Mayors of Newcastle and neighboring towns, with other members of the municipal corporations, and persons of local distinction. On reaching Wylam the train slowed until it came opposite the house where Stephenson was born, when it stopped to allow the occupants of the train to inspect the old place. Here the Mayor of Newcastle and his friends alighted, and in commemoration of the event an oak-tree was planted by his Worship the Mayor. The return journey was then made, and upon reaching Newcastle the typical engines were shunted into a siding for public inspection during the remainder of the day. The next event was a monster procession of draught horses, gayly caparisoned, with carts and lorries, and prizes were awarded for those best groomed and most tastefully decorated. Prizes were also given by the Mayor for the best decorated locomotive engine in the procession from the central railway station.

A representative procession, consisting of the members of the Corporations of Newcastle, Gateshead, Jarrow, and South Shields, the foreign consuls, various public bodies, friendly and benefit societies, trade councils, and workmen connected with the different workshops and factories of the district, together with the miners of Northumberland and Durham, paraded the streets at noon, the numbers in this procession being estimated at upwards of 40,000. The procession was divided into halves, each taking a separate route from the Central Railway Station to the Town-moor, where three platforms were provided for speaking purposes. Each portion occupied upwards of three hours in passing a given point. The streets were crowded, and, viewed from the balconies and windows, presented a spectacle which has never been equaled in the district. The platforms on the Town-moor were occupied by the various trade representatives, who delivered addresses appropriate to the occasion. Resolutions extolling the genius of Stephenson and the beneficial results of his work, and pledging the meeting to support the erection of a Stephenson College, were carried amidst great acclamations.

At an earlier hour of the morning a public breakfast was held in the Bath-lane School-room, under the presidency of Mr. Joseph Cowen, M.P., when a Stephenson Scholarship Fund was established. The scholarships will be of a threefold character—the Stephenson University Exhibition, open to any candidates in the counties of Northumberland and Durham, under twenty-one years of age; the Stephenson Engineering Exhibition, open to any candidate of sufficient merit, not more than nineteen years of age, attending any science school or class in Northumberland or Durham; and the Stephenson Science and Art Scholarship, open to any scholars from the public elementary schools of Northumberland and Durham who have passed the sixth standard. It is proposed to establish three of these latter scholarships for the children of agriculturists; three for the children of miners; and four for the children of mechanics and engineers. The scheme was launched this morning under most promising auspices, and it is likely to be carried through with great energy. In addition to this memorial of the day, a scheme is on foot to raise £20,000 to erect a new building for the School of Physical Science in the town.

The proceedings concluded in the evening with a banquet in the Westgate Assembly Rooms, at which the Mayor of Newcastle presided. There was also a popular fête in the Leazes Park, and an exhibition of models of engines, relics of Stephenson, foreign orders, letters, and pictures in the Literary and Philosophical Society's Library and Lecture Room. At ten o'clock at night there was a display of fireworks.

At Chesterfield, where George Stephenson resided in the latter part of his life, the centenary of his birth was commemorated, as well as at Newcastle. There was a procession, a special choral service in the church, a banquet, a concert, and a display of fireworks in the evening. At the Crystal Palace an exhibition of models of important railway appliances was opened in aid of the funds of the Railway Orphanage at Derby. At Rome the centenary was celebrated by the unveiling of a memorial slab at the railway station, the English Ambassador, Sir Augustus Paget, taking part in the proceedings; and several of the Berlin papers published long articles referring to this event.—*Illustrated London News.*

THE BREAKAGE OF CAR WHEELS.

IF current report speaks truly, there never were so many car wheels broken, in the same length of time, as during the past severe winter. The cause to which this has been attributed is the exceptionally cold weather. Doubtless this was one cause, but to what extent it was the *sole* one it would be both interesting and profitable to inquire. It has been shown conclusively that more rails break in winter than in summer, and, what is curious, more boilers blow up in the cold than in the warm months, but to conclude therefrom that the increase in the number of explosions or of the fracture of rails is due to the cold weather is not an adequate explanation. It would be a more correct statement to say that more *weak* boilers fail and *bad* rails break in winter than in summer. In the same way it should be said that more *poor* wheels fail in cold than in warm weather. In other words, it requires a combination (to use patent phraseology) of poorness or badness *and cold* to cause a great increase in the rate of breakage. If this were not true, that is, if the cold alone were the cause of the increase of breakages, then *all* wheels would break whenever cold weather set in. The proposition might be stated conversely, and it might be said that all wheels which fail in cold weather are bad, and the question would then come up, what is the quality in them which constitutes the badness, which, in conjunction with cold, causes them to break?

Unfortunately, we do not know to what extent railroad managers or those in charge of the cars or other rolling stock have addressed themselves to this inquiry. That it would be very profitable to them and interesting to all if they did so, and let the results of such investigations be known, is certain. Owing to the fact that every railroad company, or rather its officers, seem to use their utmost efforts to keep the reports of the number, character, and circumstances of the wheel breakages secret, it is impossible to draw any deductions from the facts, which might have the utmost value if such reports were accessible. The character and locality of the fracture of different kinds of wheels, if noted, would be almost certain to indicate defects in their form and proportions. Our knowledge of the effect of the shape of cast-iron wheels on their strength is almost entirely of an empirical character, and there has never been, so far as we know, any investigation of the subject which could be said to be a thorough or scientific study of it. A general impression exists that the plate which connects the hub with the tread of a wheel should not be made flat, but that it should have corrugations concentric with the periphery, which will permit the plate to spring somewhat as it contracts in cooling. The shape of these corrugations seems thus far to have been determined entirely by the rule of thumb. On the other hand it may be said that some of the oldest and most successful wheelmakers have been for years, and still are, making thousands of what are called single-plate wheels, in which the plate is entirely flat and without any provision whatever for the contraction of the wheel in cooling. These wheels are, however, carefully annealed and allowed to cool very slowly, so as not to contract in one part before they do in another. If the proportionate number of breakages and the character and locality of their fracture were reported, is would probably be a very valuable contribution to our knowledge of the weak points in the different patterns of wheels. Nearly all of these were designed and put into use before the increase in the weight and carrying capacity of cars, which has become the practice during the last five or ten years. They were designed to carry loads not exceeding 5,000 lb. per wheel, and without any change in their proportions they are now expected to carry 8,000 lb. One of two things is certain: either the wheels were heavier and stronger than necessary then, or they are too light and too weak now. It has also happened in many cases that the size of axles has been increased in the wheel-seat from about 4 in. to 4¾ in., without any corresponding enlargement of the hub of the wheel. It should not be surprising then that there has been this winter an unusual number of wheels that have become loose on the axles. What the circumstances seem to demand is a thorough revision of the wheel patterns and an increase in their weight and strength somewhat in proportion to that of the loads which they must now carry. It seems as though it might be best, too, to increase the size of wheels from 33 to 36 inches in diameter. The shock in going over a rough track is certainly less to a wheel of large diameter than it is to a small one, and a larger mass of metal has greater power to resist concussion than a small one. Thus a cast-iron ball one inch in diameter would be crushed under a blow from a steam hammer, whereas a fifteen-inch cannon ball would receive only a slight indentation from the same blow.

There can be no doubt, too, that wheels are often subjected to great strains by not being the right distance apart or correctly gauged. The groove in a frog through which the flange of a wheel must run is only from 2 to 2¼ in. wide, and the width of the flange of the wheel which must pass through this groove is from 1½ to 1¾ in., so that we can see how easy it would be, if the gauge of the wheels or of the track was not correct, to strain either or both of them to a dangerous degree. Every car inspector knows that not only do very great inaccuracies of this kind often exist, but also, owing to the relative position of the axles, that trucks are often "out of square," as it is called. Such defects, with mismatched wheels—that is, wheels of different diameters on the same axle—with a track in bad condition, will account, no doubt, for many breakages of wheels which would not otherwise occur, even though the weather were cold.

The great demand during the last two years for all kinds of railroad material has undoubtedly led to the manufacture and use of great quantities of cast-iron wheels of inferior quality. Railroad companies, like other consumers of manufactured articles, are inclined to be exacting somewhat in inverse proportion to the demand and the difficulty of having their wants supplied. When it is hard to have orders filled, the material received is apt to be less rigidly inspected than when all the producers are anxious to get orders.

The fact, too, that the authority to buy and the experience of the user of materials are so widely divorced on many roads brings into action two antagonistic principles. The mere buyer of wheels is apt to look only at the cost per wheel, and therefore is inclined to get them at the lowest price. The user of them would estimate their value, not at so much per wheel, but at so much per thousand miles of service. It is only when a winter like the past one is unusually destructive to bad wheels that the buyer can be made to realize that the lowest-priced wheels are not the cheapest.

What seems to be needed in car-wheels, as it is in the purchase of most other material for railroads, is some simple specifications which would designate those qualities which a good wheel must have, and which would indicate some practicable method of testing their quality. It may be, of course, that no such test is attainable, and that all that can be done is to buy wheels with a guarantee from the manufacturer for a given amount of service, thus making it his interest to furnish good material. The fact that a good quality of cast iron will stand the shocks which a car-wheel must or should resist, however, needs no proof. If, therefore, some thorough tests were made of the material of those wheels which break most, and a comparison made of its physical qualities with those of the metal of which the wheels are made that have the smallest proportion of breakages, it would be quite certain to shed some light on this important question. At any rate, railroad companies have much more to gain than to lose by making the facts known, especially if, as report says was the case last winter, they are all about equally unfortunate in this respect.—*Railroad Gazette.*

FRENCH TELESCOPIC GASHOLDER.

THE TANK.

WE are informed, in the voluminous memoir of MM. Monnier and Thibaudet, that the depth of the tank and all the other points of measurement in the vertical plane of the new work was taken in relation to a previously constructed gasholder, a dressed stone being inserted in the curb of the old tank, from the *datum* of the level surface of which all the required measurements were made. The center of the tank was marked by the intersection of lines drawn from two fixed points, selected with reference to their being always undisturbed and visible during the progress of the work. The circle of the tank was preserved by the use of a trammel in the ordinary way. The site was drained by a sump-hole suitably placed, 35 feet deep and 10 feet in diameter, in which was a centrifugal pump.

For the erection of the tank wall—there being other gasholders close at hand—an annular trench about 15 feet in width, and well timbered, was first excavated to the right depth, and the wall was finished in this trench to the full height, and backed up, before the excavation of the dome was commenced. The tank wall was built entirely in Portland cement concrete, while the flooring of the dome was of hydraulic lime concrete. Every cubic meter of cement mixture used as the basis of the concrete (*béton*) consisted of 0·9 cubic meter of washed sand and 450 kilos of cement. The hydraulic lime mortar consisted of an equal bulk of sand with 350 kilos of lime. The concrete was composed of broken stone or clinkers mixed with one or other of the above-described mortars, according to its destination, in such proportion that the volume of added mortar was 20 per cent. more than would be required just to fill the interstices between the broken stone. The stone was broken into pieces of between ⅝ inch and 2¼ inches, and was screened and washed at the same time, every care being taken to remove all traces of clay from the stones as well as from the sand used in the concrete. After the right proportions of the various mixtures had been experimentally settled at the commencement of the work, mixing machines were employed to secure uniformity in the materials.

The tank wall, of the dimensions which had been previously determined, was built, as stated, of cement *béton* laid in suitable frames by layers of about 4 to 6 inches thick, the frames being about 3 feet high. The verification of the diameter was carefully repeated by means of the trammel before and after every frame was filled, a variation of not more than ⅜ inch being permitted in the radius. The bed of already-laid concrete was always wetted, without pressure, before another layer was laid down, and the last course of every frame was left at an angle of 45°, sloping alternately to the back and front, in order to give a better bond to the following layer of the next frame. Every layer was left 24 hours to harden before the succeeding one was laid upon it. The backing was effected with soil specially set apart for this purpose, and followed the rise of the wall after about a week's interval. It was carefully watered and rammed until it did not give perceptibly under the blows of the rammers.

The wall being finished, the formation of the dome was proceeded with. The earth was formed to the required spherical shape, and any springs found were traced out and drained toward the sump-hole, by culverts passing under the wall. The *béton* was then laid over the floor.

There were 36 rest-stones, set in cement, fixed in the bottom of the tank. Blocks for securing the tank-guides were also set in the vertical wall. The interior of the tank was plastered all over with equal parts of cement and sand. The surface of the concrete was scratched, and then well wetted by a jet of water, the plaster being laid on about ¾ inch thick and well troweled. The anchorage plates for the holding-down bolts were fixed by the builder, and the curb of the tank was finished off with a course of bricks in cement, leaving an overflow at one point. When the plastering was completed, water to a depth of about 16 feet was run into the tank, and the pumping then ceased.

The total cost of the tank as executed, including expenses of supervision and the few works executed by the gas company, was about £7,520.

In some notes descriptive of the progress of the work of executing and building the tank, it appears that the method adopted of determining the proportion of interstices to the bulk of broken stone to be used in the *béton* was by saturating various samples of stone with water, and placing them in a suitable measure; the quantity of water that could be then poured among the stones until the measure was full representing the amount of the interstices. Gauged in this way, there was a mean of 46·8 per cent. of spaces among the stones. The quality of the hydraulic lime was tested by forming a block of 4 cubic inches from the mortar, mixed as specified, immersed 40 hours in water. These blocks should resist the penetration of a needle weighted to 500 grammes; in reality, the mortar resisted the needle when weighted 130 to 223 grammes above this minimum.

THE GUIDE FRAMING.

The guide framing consists of 18 wrought-iron columns with bases and capitals of cast iron. Against these columns are fixed the guides, which are continued to the bottom of the tank. Each column is composed of 13 cylindrical rings, the higher fitting into the lower, so that the diameter of the column diminishes from 3 ft. 3 in. at the base to 2 ft. 7¾ in. at the top. The lowest ring, however, which enters the socket of the base, is not tapered, but is formed out of a plate the ends of which are butt-jointed, with an internal cover-plate, countersunk riveted. The first ring is fixed to the shoe by six bolts, 1 inch in diameter; the base being held down by 3 bolts of 3¼ inches diameter.

The girders are formed in three pieces, two of these being part of the column, and the third being fixed in its place between them after the columns had been hoisted. The joints are provided with cover-plates. The girders are of the simple plate form, 1 ft. 11¾ in. deep. The columns were put together on the ground and hoisted in one piece; when fixed, the 8 in. by 8 in. H iron guides were bolted in their places.

The cost of the 18 columns and girders with the H guides was about £3,565, and the weight of cast and wrought iron used was about 188 tons 4½ cwt.

THE HOLDER.

This construction of the holder was undertaken by the same firm who obtained the contract for the guide framing.

As shown in the drawing, the inner lift is 125·75 feet in diameter and 26·25 feet deep, with a dome commencing 3 ft. 3 in. from the curb, thus leaving a flat annular row of plates outside, and rising 6 feet in the center. The outer lift is 128·5 feet in diameter and 26 feet deep.

INNER LIFT.

The sides of the inner lift are in eight rings of sheets, arranged to break joint. The top or hanging row of sheets is 10 mm. (⅜ in.) thick, butt-jointed, with ¾ in. rivets; the bottom row is 5 mm. (3-16ths in.) thick; middle rows 3 mm. (⅛ in.) thick. The light sheets are riveted with 7 mm. (about ¼ in.) rivets at about 13-16ths in. pitch. The outer ring of the crown is composed of 54 sheets 10 mm. (⅜ in.) thick, butt-jointed. The inner lap is turned up to form the commencement of the rising dome. It is remarked that this is the heaviest strained part of the crown. The top curb is made of unequal sided angle iron, the shorter side being used for the side or hanging sheets. Another angle iron is riveted round the inner edge of the first flat row of crown sheets. The number of sheets in the spherical portion of the crown, which is composed of nine rings, all 4 mm. (5-32ds in.) thick, has been thus determined: (1.) The width not to exceed 3 ft. 3 in. (2.) The number of sheets composing a ring to be a multiple of 9, in order to facilitate the execution of the work by the observance of symmetry between the rings, while preserving the broken joint.

Dome Framing.—This framing is composed of 18 principals, starting from the curb, and terminating in a cast-iron center-piece. Every principal is formed from plain 8 in. by 4¼ in. by ⅜ in. T-iron top and bottom beams, connected by diagonals of 4 in. by 2⅜ in. double T-irons placed back to back, and struts of similar design of 3 in. by 3 in. by ⅜ in. T-irons. The struts are so placed as to radiate from the central point of the sphere of the crown. It will be observed that the lower beam of the principals is horizontal. The deepest part of the girders is therefore in the center—a form suggested by the absence of a central pillar, which necessitates the construction of a principal to act like a bridge-girder from one vertical post to another on the opposite side of the holder. There are eight tiers of purlines, composed of rolled girder-iron, the outside ring being 8 in. by 2⅝ in. by 5-16 in., and the remainder diminishing to 3½ in. by 1½ in. by 3-16 in. next the center. A system of triangulation by means of 4¾ in. by ⅝ in. flat iron maintains the rigidity of the whole framing.

Vertical Bars.—The 36 vertical stays of the inner lift are of double T-iron, 8¾ in. by 3½ in., riveted to the side sheets with 9-16 in. rivets, and connected in the middle by a T-iron ring. Half of these vertical stays are connected by gussets to the ends of the principals of the dome, which they serve to support, and the remainder are connected, also by gussets, to the top curb.

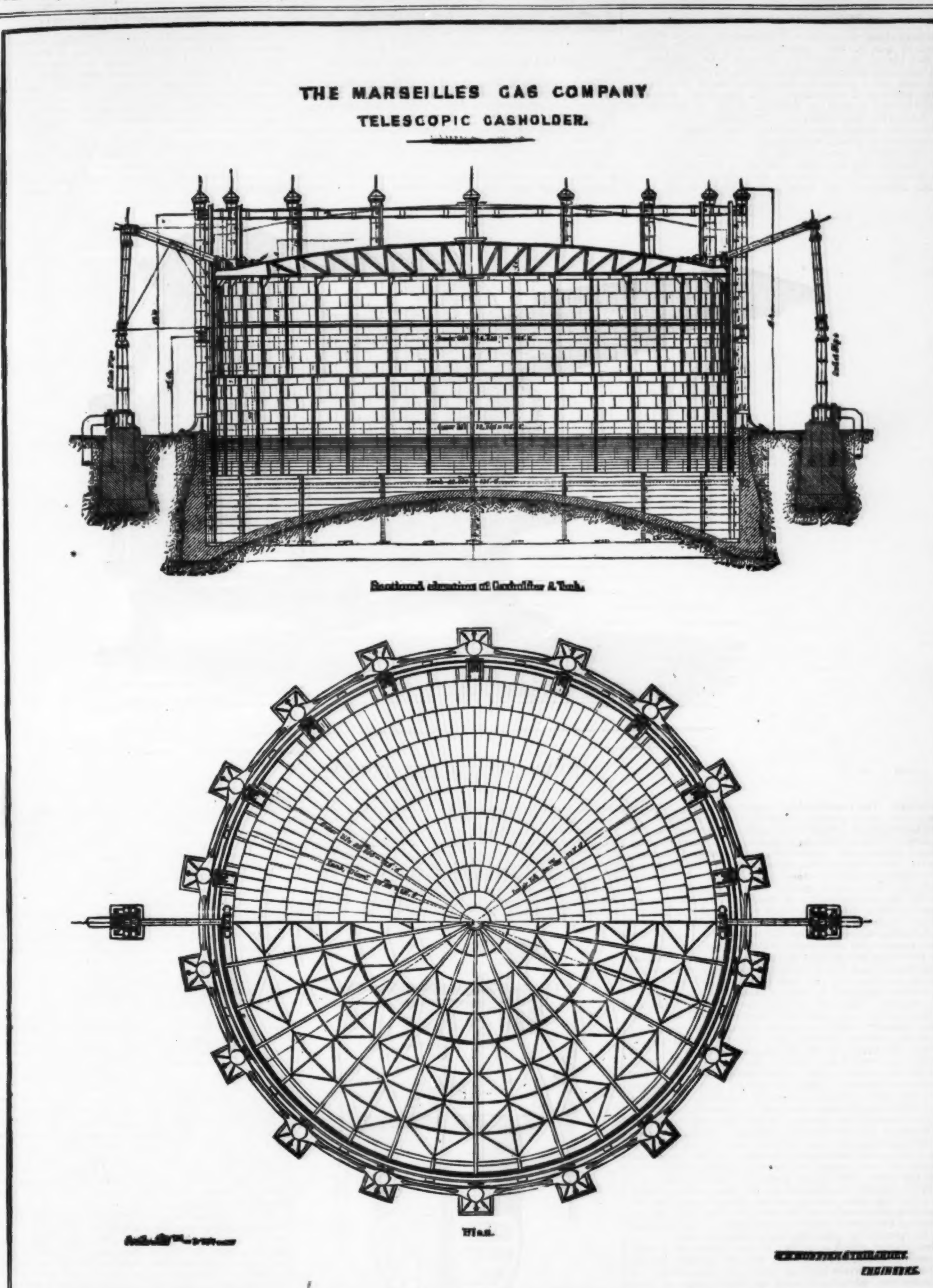
Manhole.—A manhole 6 ft. 6 in. diameter, with a lid ⅜ in. thick, is provided in the center of the dome.

Hydraulic Cup.—This is formed of channel iron 9⅞ in. by 3⅜ in. by 3⅜ in. by 9-16 in., with a cup-plate 5-16 in. thick and 17¾ in. deep, edged with two half-round irons. The inner lift having no bottom rollers, the guiding is done by the friction of the outer half-round iron against the vertical stays of the outer lift.

OUTER LIFT.

The Grip.—This is similarly constructed to the cup. The vertical grip-plate is about two inches shorter than the depth of the cup, in order to avoid damage to the seal arrangements by the accidental presence of any foreign substance which may have fallen into the cup.

The Sides.—The sheeting is similar to that of the inner lift. The hanging row is 3-16 in. thick, and the bottom row is



of equal thickness. There are 36 vertical stays of double T-iron riveted against the side sheets. These stays are provided at bottom with small cast-iron shoes, to give a larger bearing upon the rest-stones. There are two bottom angle-irons, between which are fixed the bottom roller carriages.

GUIDING ARRANGEMENTS.

The system of guides consists essentially of 54 pairs of tangential rollers in three different horizontal planes: (1) On the top of the inner lift. (2) On the top of the grip of the outer lift. (3) At the bottom of the outer lift. Besides, the bottom of the inner lift is guided by the friction of the half-round iron on the cup against the vertical stays of the outer lift. The top carriages are all made to carry two tangential and one radial roller, in bearings of "anti-friction" metal. Play to the extent of 20 mm. (¾ in.) is allowed to the radial rollers, and of 15 mm. (9-16 in.) to the tangential rollers.

INLET AND OUTLET PIPES.

These pipes are alike, and are situated opposite each other. Each is composed of a fixed cast-iron column, secured to a masonry base. The top of the column carries a knee-joint, after which comes a sheet-iron pipe 29 inches in diameter. Another knee-joint intervenes between this and the next sheet-iron pipe, which, in its turn, is connected to the outer row of the crown plates by a third joint. Walker's valves, 700 mm. in diameter, are used for the inlet and outlet.

EXECUTION OF THE WORK.

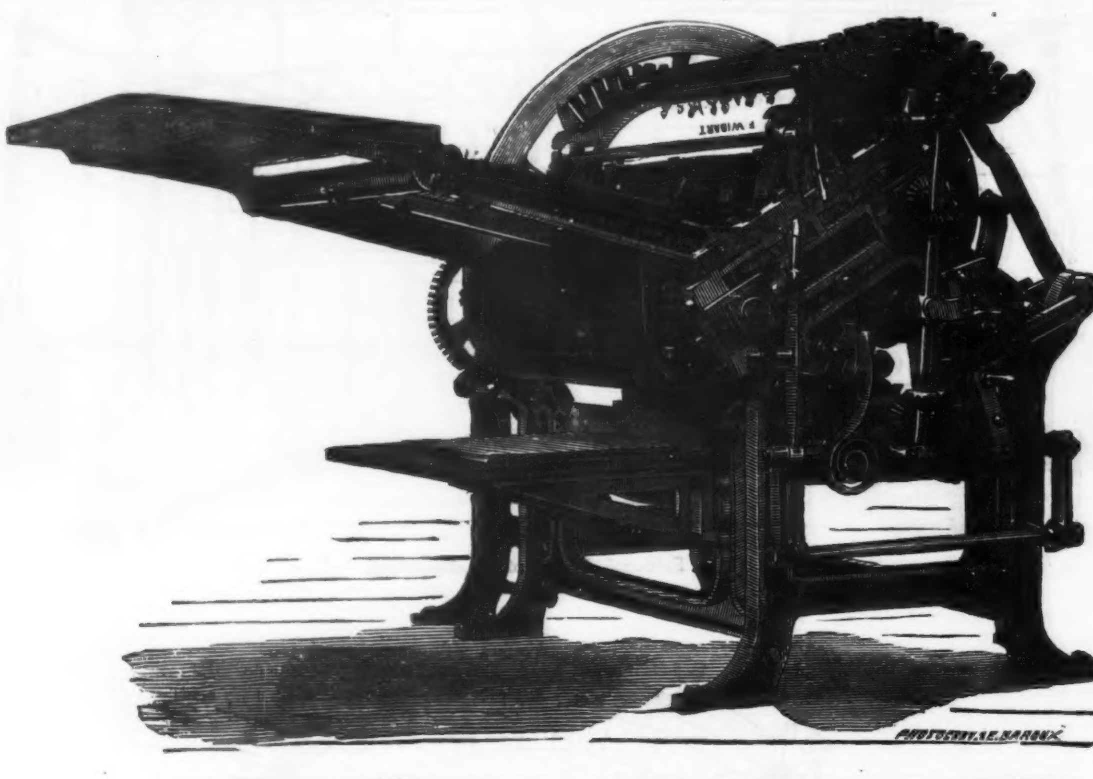
The inner lift was built up from the rest-stones in the tank, and the dome was fixed by means of a traveling scaffold. The outer lift was erected on the ground, and lowered by screws in the usual way. The sheets were put together without paper or hemp, and were set up where necessary. The inner lift alone gives a working pressure of 74-10ths, and the two lifts together give 92-10ths pressure. The cost of the holder was £7,200, making, with the cost of the tank and guide framing, a total cost for the whole work of £18,285, or about £28 5s. per 1,000 cubic feet of useful holder capacity. The holder has continued to give complete satisfaction since it has been in operation.—*Journal of Gas Lighting.*

IN cases of confirmed baldness the new remedy proposed is to remove the scalp bit by bit, and substitute, by skin grafting, pieces of healthy scalp taken from the heads of young persons. The success which has heretofore attended operations of this nature in cases of scalp wounds gives a promising outlook for this new mode of curing baldness, and perhaps the day is not far distant when the shining pates of our venerable fathers will bloom with the flowing locks of youth.

ZINCOGRAPHIC PRESS.

SENEFELDER, the inventor of lithography, in a work published by him in 1818, pointed out a method of printing on zinc plates, the principle of which was analogous to that employed with lithographic stones. In 1829 Mr. Bregaot took out a patent on the application of this process to the printing of large maps. The process was afterward improved and applied to different kinds of printing by Mr. Kaeppelin, who styled it "zincography."

Since that period many inventors, recognizing the great advantages that would result from the substitution of zinc for lithographic stones (which are becoming rarer and more costly every day), have carried on their researches in this direction, without, however, succeeding in overcoming all the difficulties that seem to be inherent to this mode



NEW ZINCOGRAPIC PRESS.

of printing. The imperfections connected with all attempts to make the art a practical success were due more especially to a want of proper preparation of the zinc, and to the impossibility of fixing the plates firmly enough to the ordinary lithographic presses in use. These difficulties, however, have finally been surmounted by the invention of the machine represented herewith.

This new press, in its general form, is a species of rolling-mill, the two cylinders of which can be made to approach or recede from each other so as to give as light or as heavy an impression as may be desired. The larger of the cylinders, which occupies the central part of the machine, receives the zinc plate, which is fixed so firmly to it by revolving clamps as to make it almost an integral part of the apparatus. These clamps, which may be caused to move in any direction that may be desired, allow the plate to be easily regulated in any position so as to obtain an exact register. The half of the cylinder not occupied by the plate serves as a table for distributing the ink. The smaller cylinder, which is placed alongside of the larger one, is the printing cylinder, and carries the paper to be printed. By means of the guides and points with which the press is provided the register may be accurately regulated, and as correct an impression obtained as with the best lithographic presses. The ink trough, which is located under the larger cylinder, is easily regulated, and is provided with a small apparatus which furnishes instantaneously and exactly the quantity of ink that may be desired. The fountain and distributing rollers are moved by means of levers between the large cylinder and the ink trough in such a way as to take up and distribute at the proper moment the ink over the part of the large cylinder which serves as an ink table. The upper portion of the machine, over the large cylinder, is occupied by the plate rollers, which, when the ink table passes, become charged with the ink which they afterward distribute over the zinc plate, the latter having first passed under the moisteners. The machine may be operated by either manual or steam power.

Zincography, which is, as may be seen, a new art, is making rapid progress, and is tending more and more to become a substitute, in certain kinds of works, for lithography. It has numerous advantages over the latter, some of these being the following:

The capital required to carry a stock of zinc plates is only one-twenty-third that which it takes for the same number of lithographic stones. The storage of the zinc plates requires only one-eighth the space taken up by lithographic stones.

Precisely the same kind of work may be executed on the zinc as on stone, with just as great perfection, and in less time.

The designs, of whatever character they may be, are more firmly fixed on the zinc than on stone, thus allowing of a greater number of impressions being taken.

The zinc plates prepared by this process may be kept for an indefinite period without alteration.

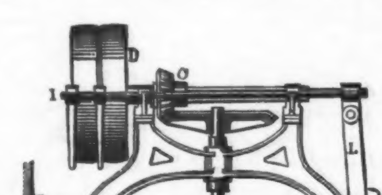
Corrections, additions, or erasures may be as readily effected on the zinc as on stone.

For impressions of large dimensions, such as maps, posters, etc., there can be no comparison between the two processes, because of the high price of large lithographic stones and the impossibility of finding these in some cases of sufficient dimensions. In fact, the size of the stones is limited, while that of the zinc plates is much less so.

APPARATUS FOR PREPARING STARCH.

THE starch which is employed for giving muslin and lace curtains their last finish is generally prepared by boiling it in an open or closed vessel, with or without a double bottom. To clear the solution alum is added.

This method is so inconvenient that a Saxon manufacturer has been led to devise a new form of apparatus, shown in the annexed figure, and which permits of the starch solution being prepared without the necessity of using alum. The new apparatus consists of a boiler, A, closed by a copper lid having a steam-tight lining. In the center there is a vertical axle, B, which is actuated by the bevel-wheel, C, by means of the pulley, D. On the lower end of this axle are mounted the four stirring paddles, E, which, by their revolution, keep the material in constant agitation. The steam, which is led in by the pipe, F, enters the hollow axle, and is distributed throughout the boiler by means of a series of apertures, F', F''. The admission of steam is regulated by a cock on the pipe, F, while another cock, H, serves for drawing off the water from the boiled starch. The apparatus is also provided with a starting lever and a safety-valve. When the



APPARATUS FOR PREPARING STARCH

starch has been introduced through an aperture in the cover, the steam cock is turned on; the agitator, making 30 revolutions per minute, is started; and the starch is submitted to ebullition under a pressure equivalent to twenty-five pounds or more. The pressure of the steam prevents the choking up of the pipes. In three quarters of an hour there is obtained a product ready for use, and which recommends itself by its excellent quality. The operation takes just one-fourth the time that it does by the ordinary methods in use.

CHICHESTER CATHEDRAL.

THE South Saxon or Sussex Kingdom, extending along the seacoast from Hampshire to Kent, in the sixth and seventh centuries of the Christian era, was almost separated from the rest of England by the great forest of Anderida, which filled the whole "weald" between the North and South Downs, and by the marshes that lay to the east and to the west of Sussex, where the South Downs end, there giving place to the lower shores. This sequestered situation was probably the cause why Sussex was the last of the Saxon settlements in England to receive Christianity.

It was about the year 650 that Wilfrid of Northumbria, returning from France, where he had been consecrated as Archbishop of York, was shipwrecked on this coast and had a narrow escape of being killed by the barbarous people. In memory of his deliverance, Wilfrid came back, thirty years later, when he was expelled from Northumbria, and undertook the religious instruction of the South Saxons. He was assisted by their King Ædelwalch and Queen Eabba, who abjured the worship of Thor and Odin; and he fixed his abode on Selsey Island, which was the seat of the bishopric he founded until the Norman Conquest. In 1075, when Stigand, chaplain to William the Conqueror, held this see, it was removed to Chichester.

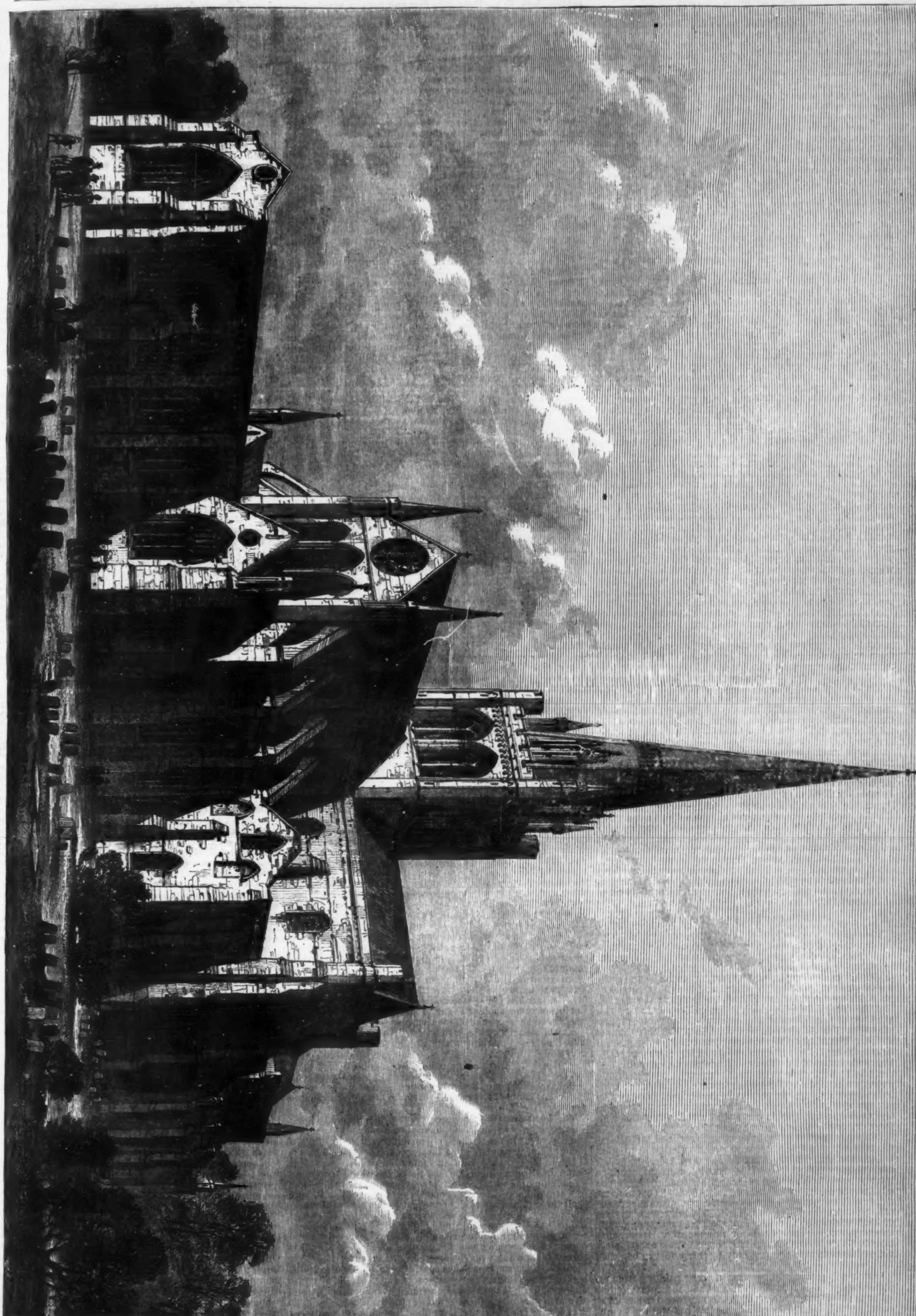
The list of subsequent bishops of Chichester includes Bishop Ralph, a bold supporter of Anselm in his struggle for the privileges of the clergy against William Rufus and Henry I.; Bishop Neville, chancellor of England from 1223 to 1238; Bishop Richard de la Wych, under King Henry III., a Dominican monk who was canonized as a saint; Bishop Gilbert, likewise renowned for his piety; John Langton and Robert Stratford, who were chancellors of the realm; Adam De Moleyns, a diplomatist in the reign of Henry VI.; Reginald Pecock, a great theologian and opponent of the Lollards, author of "The Repressor of Overmuch Blaming the Clergy," but himself obliged to recant some propositions contrary to the Romish creed; Bishops Sherborne, George Day, and Christopherson, who were strenuous against the Protestant Reformation; and Richard Montague, a great High Churchman in time of Charles I.

The cathedral was built first in the Norman period, by Bishop Ralph, on the site of a Saxon monastery dedicated to St. Peter, and part of the nave and choir is still Norman, with two aisles; this portion was restored twenty years ago. The retro-choir, of Transition architecture, was constructed early in the thirteenth century, and is remarkable for the elegance of the detached shafts of Purbeck marble, standing outside the massive circular piers; the great pier arches are circular, inclosing pointed arches. The Lady chapel, by Bishop Gilbert, is also beautiful.

With regard to the exterior of this cathedral, as shown in our illustration from the drawing by Mr. S. Read, its principal feature is the spire, which, though far less lofty (being 271 feet) than the one at Salisbury, is finely proportioned and bears a harmonious relation to the lower group of buildings. The tower from which it rises was erected, probably, by Bishop John de Langton, in the early part of the fourteenth century. The upper part of the spire was rebuilt by Sir Christopher Wren, who furnished its interior with an ingenious pendulum stage hanging from the summit inside, to preserve its perpendicular against the force of high winds. The west front, originally Norman, is of the early English style, in three stories, surmounted by a gable. It was flanked by two towers, but the north tower has been destroyed.

Chichester Cathedral has some interesting works of sculpture among its monuments, including two or three fine groups by Flaxman, and bass-relief slabs of ancient date, rather curious in design.—*Illustrated London News.*

BEETLES AS A TEST OF WOOL.—A French entomologist asserts that the wool of different countries can be distinguished in market by the beetles which frequent the bales. He has identified 47 species in Australian wool; 52 in South African wool; 30 in South American wool; 16 in Spanish, and 6 in Russian wool.



CHICHESTER CATHEDRAL.—DRAWN BY S. READ.

ART ON THE STAGE.

Scene painting is an art by itself. There is no other branch of painting just like it, either in the variety of subjects embraced or in the methods employed. The thorough scenic artist must be equally at home in landscape or marine work, architectural or fresco. He is not permitted to cultivate any particular branch of his art, nor any favorite style. He must be able to produce at any time the wild mountainous passes of Switzerland or the flat meadows of Holland; the green lanes of home-like England or the winding valleys of romantic Spain. In his architectural work he cannot devote himself to the Gothic or the Romanesque, but must be equally master of the Moorish, the Greek and the Oriental. He may to-day be called upon to paint the Temple of Minerva, and to-morrow the Mosque of Omar; this week the Windsor Hotel, and next week the Palace of Versailles. His art knows no boundaries, and his scope is confined by no limits. The universe must be at his command, and things unseen must live in his imagination. The methods by which he works and many of the materials he employs are altogether different from those employed by the ordinary oil or water-color painter. They approach more nearly to those of the latter, yet even here certain qualities of the colors used by the scene painter constitute a sharp, dividing line.

In the first place, the ordinary water-color painter works upon paper. The scene painter uses canvas. He first makes a pasteboard model of his scene and gives it to the stage-carpenter, who builds the frame work and pastes the canvas upon it. It is then ready for the "paint frame." This is a huge wooden affair, hung upon ropes, with counterweights attached. It is usually placed against the wall at the back or side of the stage, and has a windlass attached by which it may be hoisted and lowered. The artist works upon a bridge built in front of this frame and at its top when the bottom is touching the stage. By hoisting or lowering the paint frame he is enabled to reach any part of his scene. He is provided with plenty of brushes, ranging from a heavy two pound brush, such as is used by house painters, to a small sharp one for drawing fine lines. In addition to these he has several whitewash brushes for laying in flat washes and skies.

His colors are kept in buckets, tin cans, and earthenware vessels. His palette is a long table with partitioned compartments on the top to hold small quantities of color. Give him now his palette-knife, his rule, plenty of twine and sticks of charcoal, and he is ready to go to work. His first duty is to "prime" his scene. This is done with a plain coat of white. This color and all others used by him are mixed with "sizing," which is simply a weak solution of glue. Working with colors mixed in this way is called painting in distemper, and has certain advantages which will be spoken of further on. The priming coat is laid on with a heavy whitewash brush, care being taken to drive the color well into the canvas. Sometimes heavy unbleached muslin is used; but the usual material is duck.

After the canvas is primed and dry, the artist is ready to draw. Most scenic painters do their first drawing in a very sketchy manner. After the charcoal outline is finished, it is gone over carefully with an ink prepared especially for the purpose, and not used in any other branch of art. In architectural drawing this part of the work is necessarily done with the greatest care, as regularity of outline and accuracy of detail are absolutely necessary. A scene painter's outline for a landscape, however, looks very much like the off-hand outline productions hastily done by an old hand at sketching from nature. The scene painter must be a master of perspective; for street scenes and palace corridors are frequently produced by him. The method of drawing in perspective on a large scale is curious, though substantially the same as that usually employed. The artist selects his "vanishing point," usually outside of his scene, and attaches to it by a pin a long piece of twine. Beginning at the top of the scene he marks off, in the foreground, the distances between his lines. He then blackens the twine with charcoal, and, laying the loose end on his first mark, draws it tight and snaps it upon the scene, making a line in the same manner as a carpenter does upon a long board. These lines are afterward gone over with ink and ruler. In this way he is able to produce a perfect perspective. Exterior scenes, in which a castle or other large building appears, often have the perspective increased in effect by continuing a wall or rampart down the stage upon a separate piece set exactly in the line of perspective.

SECRETS OF THE SCENE PAINTER.

The next step is the laying in of the groundwork. The sky is, of course, the first point. This is done with whitewash brushes, the painter being absolutely free from all restraint in his method of putting on the color. The principal point is to get it on quickly. And here the great advantages of painting in distemper become thoroughly plain. These advantages are two in number: the first is, that the color dries very quickly, thus affording the artist a high rate of speed in working; secondly all the colors retain when dry precisely the same tint as they had before being mixed. The addition of the sizing makes each color several shades darker than it is when simply in the powdered state. The knowledge of this fact and thorough understanding of the effect the tints will produce after drying is one of the great secrets of the art. Oil painters of high standing have been known to try the distemper method with utterly disastrous results. Colors mixed with oil always darken several shades and remain dark. Colors mixed with sizing always dry out to their original shade.

Different painters have different methods, and there is as much variety in the schools of scene painting as in other branches of art. The German, French, and American artists use opaque washes, or, as it is usually expressed, work in "body color." The English school, in which the greatest advances have been made, use thin glazes. This in scene painting is the quickest and most effective. Morgan, Marston, Fox and Voegtlin are among the leading representatives of this school in America, and their method is gradually spreading among the artists of this country. Its rapidity may be judged from the fact that one of these artists lately painted a scene measuring twenty by thirty feet in less than four hours.

One of the greatest differences in scene painting from ordinary water-color painting is that, while the colors of the latter are transparent, those of the former are opaque. For instance, the water-color painter can lay in a wash of yellow ocher, and, by covering it when dry, with a light coat of madder lake, can transform it to a soft orange. In distemper, however, the coat of madder lake would not allow the yellow to show but would completely hide it, and the tint presented would be pure pink. From this fact results a total difference in the painting of foliage. The water-color painter lays in his light tints first and puts in his shadows afterward. The scene painter may do this or not as he pleases. He may put his light tints over his dark ones and they will not lose any of their brilliancy. The advantage of this in regard to speed may be easily seen. If the water-color painter wishes to put a high light in the middle of a shadow, he must first erase with a sharp knife a portion of his dark tint, or else put on a heavy spot of Chinese white. Over the spot thus erased or whitened he puts the required tint. The distemper painter is relieved of this roundabout process, for he simply dots in his light color wherever he needs it over the darker shade and it shows with perfect brilliancy. Again, in painting skies the scene painter works by a method of his own, not unlike that adopted by oil painters. The water-color painter must leave all the broad lights of his sky when putting in the main color, and is obliged to work with his tints wet. The scene painter may lay in the entire sky with blue, and paint his light yellowish clouds over it afterward. If the ordinary water-color painter were to do this, his clouds would be green. Some scene painters, however, work their entire skies wet. The effect of a sky painted thus is always very fine, but only an artist thoroughly conversant with the values of his several pigments can do this. For the colors, it will be remembered, present a very different appearance when wet from that which they have when dry.

Scene painting has become so important an art that one large firm in this city makes a great specialty of imported materials. There is a long list of colors and other things used exclusively in scenic art, and improvements are being constantly made. Formerly scene painters were obliged to grind their own colors, but these are now prepared in "pulp"—that is, ground in water. Among the colors used almost exclusively by scenic artists are English Paris white, zinc white, silver white, drop black, Frankfort black, Turkey umbers, Italian siennas, Cologne earth, Dutch pink, Schweinfurter green, Neuwieder green, ultramarine green, Bremen blue, azure blue, Persian scarlet, Turkey red, Tuscan red, Solferino, Magenta, Munich lake, Florentine lake, Vienna lake, and blue lake. Some of these colors are also used by fresco painters.

Those which are never used except by scenic artists are celestial blue, golden ochers, green lakes, Milori greens, French green and yellow lakes. The colors specially imported for scene painters are carnation, royal purples, green lakes, and the English chromes. Indigo is used in very large quantities by scenic artists, but it is used very moderately by water-color artists. It adds considerably to the expense of getting up scenery, as it costs \$1.60 per pound in dry color, and \$1.75 in pulp. The most expensive colors are royal rose madder, \$2.75 per pound; scarlet lake, \$1.75; Magenta, \$1.75; Solferino, \$1.75; royal purple, \$2.75; mauve lake, \$2.75; crimson, carmine, and Munich lakes, \$1.75; Florentine and yellow lakes, \$1.50. Ten pounds of indigo alone are sometimes used in a single scene.

OTHER MATERIALS USED.

The scene painter, however, is not confined to colors in producing his effects. There is a number of other materials of great importance in scene painting. The gorgeous dashes of blue, crimson, yellow, and purple that make the resplendent fairy grotto are not alone sufficient. The glitter that is seen on the many-colored stalagmites and stalactites is produced by ordinary gold and silver leaf. Sometimes it becomes necessary to produce upon the scene a smooth, glittering surface which shall be colored. This is produced by foil papers. They are made of paper with a polished metallic surface, and are very effective in fairy scenes. What are known as bronze powders are made of all shades. They are metallic powders of gold, silver, bronze, steel, blue, red, purple, and other shades. A brush full of glue is drawn across the required surface and the bronze is spread over it. The consequent appearance is that of a rough metallic surface similar to that of frosted silver.

In some scenes it is necessary to represent precious stones. The jewels in the walls of some Eastern despot's palace cannot be imitated by paint with a sufficient degree of realism to stand the glare of gas and calcium light. Hence, theatrical art resorts to what are called "logies." These are made of zinc, in the shape of a large jewel, and are set in the canvas. They are made in all colors; and thus, by a very cheap and easy process, the barbaric splendor of Persia or of Turkey may be reproduced in all its original opulence. Sometimes it becomes necessary to represent that changing sheen that is visible upon highly-polished metals when exposed to the rays of the sun. This is done by means of colored lacquers. The surface of the metal is painted, and a wash of these lacquers, blending from one tint into another, is put over it. The light reflected from these different colored washes produces the desired effect and gives a highly realistic representation of a surface of metal.

An ice scene is never complete without something to produce glitter and sparkle. This effect is produced by "frostings" of crushed glass, which are made to adhere to the canvas in the same manner as the bronze powders. The elaborate ornamental work in interior scenes is always done by means of stencils cut in pasteboard. There are books published on fresco painting which give large numbers of beautiful designs for panels, ceilings, mouldings, and other ornamental work. Every scene painter has a collection of these works. The ingenious artist, however, is constantly combining the different designs, and often invents new ones. He is thus enabled to present to the public an ever-changing variety.

The last thing that the scene painter does before the production of a new play is to have his scenes set upon the stage at night in order that he can arrange the lighting of them. The "gas man" of a theater is the artist's mainstay. It lies in his power to ruin the finest scene that was ever painted. Ground lights turned too high upon a moonlight scene, calciums with glass not properly tinted, or the shadow of a straight-edged border-drop thrown across a delicate sky—all these things are ruin to the artist's most careful work. The proper lighting of a scene is, therefore, a matter that requires the most careful study. The artist sits in the center of the auditorium and minutely observes every nook and corner of his scene under the glare of gas. Here a light is turned up and there one is lowered until the proper effect is secured. The gas man takes careful note of his directions, and the stage manager oversees everything. Long after the audience has left the theater on the night before the production of a new play, the stage hands, the artist, and the stage manager are at work, and the public sees only the charming result of their labors when the curtain rises on the next night.

Scene painters are well paid, their salaries ranging from \$40 to \$150 per week. One well-known artist in this city paints only by contract. He is a very fast worker and receives from \$100 to \$250 for one or two scenes, which, at the close of the play's run, are ruthlessly blotted out with the inevitable whitewash brush. Hence these beautiful stage pictures are worth just the canvas they are painted on—twenty-one cents a yard.—*New York Tribune.*

THE MANUFACTURE OF BANK BILL AND BOND PAPER.

Of all the papers made in the country, that manufactured at Coltsville, in the town of Pittsfield, Mass., is perhaps the most valuable. Its value consists especially in the fact that it is not purchasable, at any price; because being "distinctive," its manufacture also exclusively in the hands of and for the benefit of "Uncle Sam" himself, its price is incalculable. The manufacture of this "distinctive" paper is therefore not a small industry for Berkshire, and it would be hard to find in all the country a mill better adapted to its manufacture, it being just small enough to guard well, and just large enough to afford excellent facilities for the purpose. Its location, first, is favorable, being located in one of the loveliest portions of the country, among the "Berkshire hills." Coltsville is not even a hamlet. The only street, a highway, leading from Pittsfield to Dalton, is shaded on each side by a row of elegant maples, and it has neither the store, blacksmith shop, nor other adjuncts of an ordinary country village, save the hotel, a quarter of a mile distant. It is isolated and yet in the very center of a busy section. Coltsville, so named for the late Hon. Thomas Colt, is on the extreme eastern boundary of Pittsfield, three miles from the "center," and its next door neighbors to the east are the extensive mills of the Cranes, at Dalton, whose reputation for years as bond-paper makers has been world-wide, by whom (Crane & Co.) the government mill is now owned and operated, the Treasury Department taking the amount demanded.

The mill has a "history," as almost everything in Pittsfield has. Its site was for years occupied as an iron forge, one of the first in Berkshire. From 1820 to 1848 it was owned by various firms and used by them as a tannery. In the latter year it was converted into a paper mill under the firm name of Wilson, Osborn & Gibbs. In 1851, the late Hon. Thomas Colt, brother of the present Judge James D. Colt of the Supreme Court, became a partner, and in 1855 sole owner. In 1862, Mr. Colt's increasing business demanded better facilities, and the water power being sufficient, a new mill was built, then one of the handsomest and most substantial in the county, though by no means the largest now. It was built under his own personal supervision, and operated by him for the manufacture of collar and ledger papers until 1873. It is 100 by 50 feet in the area, two stories high, besides basement and attic, and a "lean-to" in the rear 100x28 feet. It has three engines, one a double-engine, and a 64-inch Fourdrinier machine. It is lighted by gas made on the premises, and heated throughout by steam. In 1856, Mr. Colt experimented successfully with a new feature in the county or State, viz., artesian wells, in order to obtain a better supply of pure water than the mountain springs or brooks afforded. The first was 250 feet deep, and he met with and overcame the usual obstacles in penetrating strata like those of the Berkshire geological formation. This proving inadequate, in 1868 he followed it with another, 501 feet deep, both affording 575,000 gallons daily of the purest water to be obtained. Their cost was \$10,000. Mr. Colt, however, failed in the panic of 1873, and died a few years later, highly esteemed and respected by all who knew him. The mill was afterwards operated by other parties on book and news papers, and after remaining idle for about a year, was purchased by the Messrs. Crane & Co., about two years ago, who at once made extensive repairs, and put the mill in proper condition, to begin upon their contract with the government, which took effect in the summer or fall of 1879.

The first floor contains the packing, shipping, and finishing room, superintendent's private office, counting and examining rooms, where the ladies employed by the Treasury Department are busy counting and examining the finished sheets. The manufacture of "distinctive" paper is not different from that of other fine or bond papers. The stock is, of course, all linen, and new; no old rags or stock being used, and about one-fourth of it is prepared at the "upper" or "[illegible]nd" mills of the Messrs. Crane & Co., one mile further up the stream in the town of Dalton. In its manufacture, quality, and not quantity, is the principal consideration. There is, therefore, no hurry, and the workmen are all experienced; the best grades of stock are used, and great care is taken not to pull the fiber, therefore giving the paper strength. The water is of the purest character, one spring 1,000 feet southeast supplying 100 gallons a minute, and another 1,[illegible]00 feet east, supplying about as much more. The artesian wells are not used. The water is strained three times before entering the engines, in order to insure as near absolute purity as possible.

Previous to the contract with Messrs. Crane & Co., the paper for the government had been manufactured for several years in Pennsylvania, and was made under the process known as "localized fiber." It was distinctive to a certain extent, but with the award of the contract to the Messrs. Crane it came to be more distinctive than ever. The red and blue silk fiber is a part of the paper itself, and it has also another distinction, both the idea of the then Secretary of the Treasury, Hon. John Sherman, of having red and blue silk threads running through the sheet, so that there are two lines passing along the edge of every bank bill and treasury note since the series of 1880, one on each side. Bond papers differ slightly from that for bank bills, as the parallel silk lines run a little differently. This paper is used for all moneys, securities, bonds, checks, and drafts of the government; the paper for checks, however, being of double weight. The Messrs. Crane are the first and only firm who have made the paper with the parallel silk lines. The "distinctiveness" of the manufacture from other papers comes in the machine room, and is a secret process owned exclusively by the government, and from which time the paper begins to come under government control. Accounts with it begin to be kept here, as with money. It represents, if possible, more than money, because it is kept out of bad hands. In an order of the Secretary of the Treasury dated June 10, 1879, he says that he has adopted a distinctive paper, which will be used after the then supply is exhausted, until otherwise ordered. One of its features, he says, is the introduction of colored silk threads into the body of the paper while in the process of manufacture, in combination with distributed silk fiber of different colors. Of the penalty, he says: "That every person who has or retains in his control or possession the distinctive paper shall be punished by a fine of not more than \$5,000 or be imprisoned at hard labor not more than fifteen years, or both."

The mill itself is, therefore, strongly and securely guarded every day and night by government guards, all of whom are old soldiers, with all the appliances of time watches and other safeguards, and their rooms are an arsenal in a small

way. No one not employed there is allowed to enter the building without special permission from the superintendent, while the workmen are the most trusty of all those whom the firm employ and well know. On the machine, a 62 inch Fourdrinier, the silk threads and fiber become a part of the paper itself. The sheets come from the machine three times the size they are sent to Washington, and are therefore $24\frac{3}{4}$ by $40\frac{1}{2}$ inches. A counting machine at the cutter and "lay-boy" accurately registers the number, which must be agreed with perfectly in all the subsequent countings which are made and daily reported at the superintendent's office. Let us follow the sheet from the machine room to its destination:

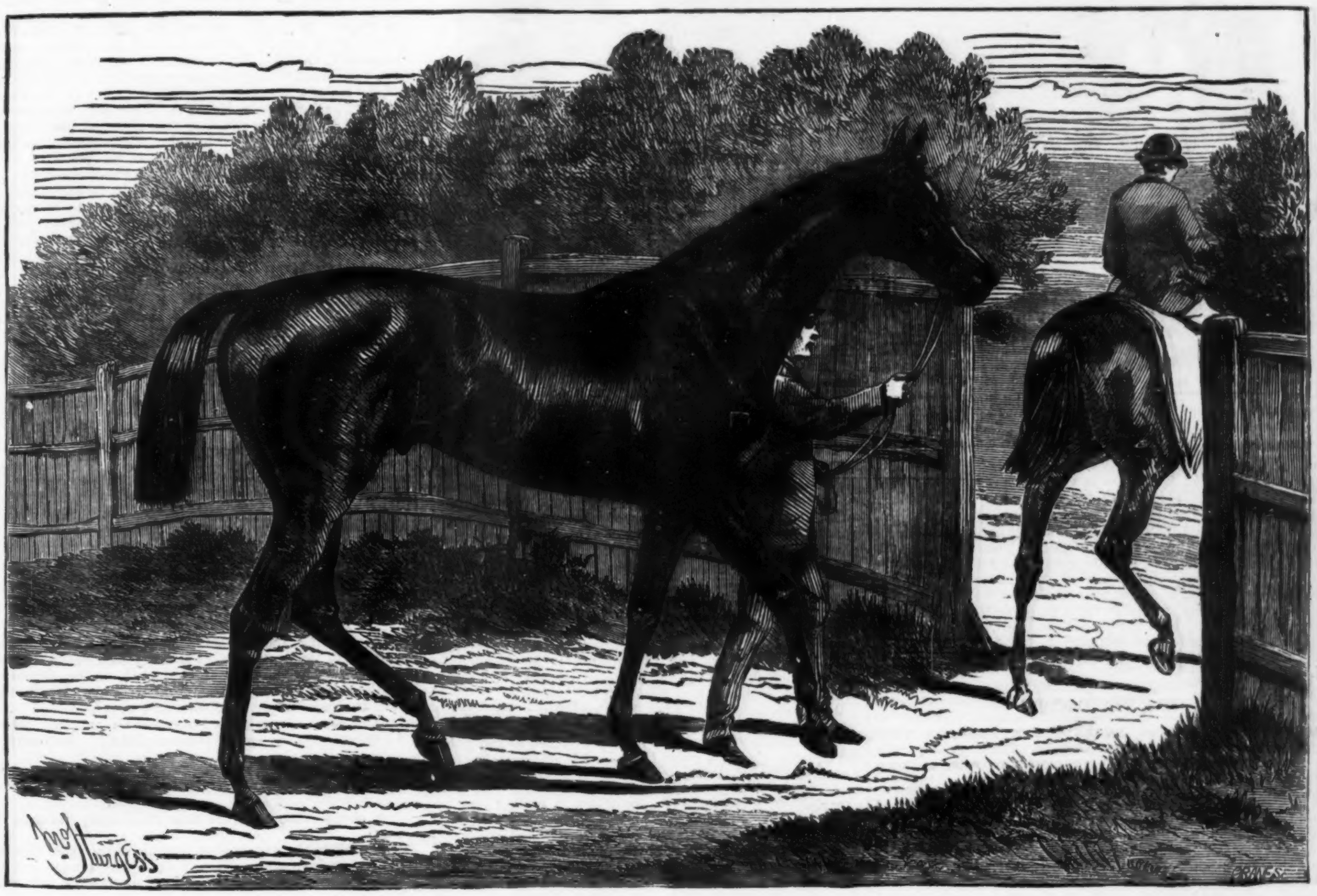
The sheets are now taken to the drying rooms in the second story (the machine room, 100 by 40 feet, being in the basement). The upper floors are entirely under control of the government, and a guard is constantly maintained at the door, so that no one is allowed to pass not authorized to do so. Three or four days are occupied in drying the sheets, when they are taken to a room adjoining, and counted. From there they are brought again to the first floor, and pressed, and then cut into sheets, accurately $8\frac{1}{4}$ by $13\frac{1}{2}$ inches. The paper is not calendered. At this point it is turned over to the government and invoiced, having been counted and the regular and necessary entries having been made for verification. From there it goes at once to the examiners and counters, and that, by the way, is one of the most interesting portions of the work to an outsider. Their room adjoins that where it is pressed, cut, packed, and shipped, and is just across the hall from the superintendent's office. The ladies, of whom there are a dozen, are experts in their business, and are appointed by the Secretary of the Treasury, in whose office all or nearly all of whom have served long terms of service. They are mainly the widows or daughters of soldiers, and are appointed through the personal influence of members of Congress or Senators. It is surprising how quickly an imperfect sheet is detected in the examination, and a mere speck or other defect consigns the sheet back to the pulp again. Everything is done by twos or in pairs, to secure accuracy and verification of each other's work. The spoiled sheets are cut first into such small bits as to be unfit for any further use, and then sent back to the pulp, so carefully guarded that none leaves the building. The counting is also just as accurately done, and it is surprising how fast the nimble fingers go over the sheets. One lady counts, and another, sitting opposite, verifies her work. A report is handed in each day to the superintendent, who keeps a record of and account with it. About 40,000 sheets a day is the average counting, but some are even more expert than that, if necessary, especially in the Treasurer's office. The hours of work for the government employees are the same as at the Treasury Department, of which it is really a part, and they are governed by the same rules and regulations as to conduct.

After being counted the paper is put into packages of one thousand sheets, subdivided into hundreds, and otherwise numbered so as to be easily traceable, and compared with the accounts kept about it by the superintendent. It is then weighed—one thousand sheets weighing about eleven pounds—and packed nicely into boxes, twenty thousand sheets in each box, each of which is numbered, and directed to the Secretary of the Treasury, at Washington. To the express car at Pittsfield, though locked in iron bound boxes, it is carefully guarded, and in due time arrives at Washington, directed to the Treasurer. Here it is counted and examined again, and any defective sheets which were overlooked, thrown out. From there it is sent as required to the Bureau of Engraving and Printing, where it is again counted and inspected. Each sheet makes four bank bills. It is proper here to remark, in passing, that but a small percentage of the sheets are thrown out, even at the first counting and examination, and still less in the two subsequent examinations, at Washington. All the countings must agree with those made at the mill, and especially the first registered on the "lay-boy," so that it is impossible to lose a single sheet that cannot be accounted for. It is kept watched of so perfectly that any defect can be traced from the moment it leaves the machine until it is given to the people in bank bills, bonds, or checks, and the government's care of it is never lost.

As has been before stated, the use of the silk fiber and parallel lines begins with the series of 1880.

The manufacture of the distinctive paper began at Coltsville, in October, 1879, and Rev. J. K. Burket, a Pennsylvanian and a retired clergyman, who for some time had charge of the Pennsylvania mill, was the superintendent. He was a thoroughly capable gentleman, but his health becoming impaired he returned to Washington the past winter, and is now in the Treasury Department. His successor and the present superintendent is Captain W. H. Higdon, an Ohioan, and a native of Cincinnati. Although still a young man, he has been in Uncle Sam's service since May, 1861, having an honorable record in the army during the war. He was for several years in the revenue service at Cincinnati, where a business of about $12,000,000 a year is done, owing to the immense distilleries there, and later had charge of the paper room in the Treasury Department. He took charge of the Coltsville Mill in February last. By his long experience, he is thoroughly conversant with the business which he has been called to supervise.

Major J. P. McElrath, a government detective, has been stationed in Pittsfield ever since the mill began operations. He is from Ohio, and was a major in the late President Hayes' regiment, with whom and his family he was on the most friendly personal relations, and was treated at the White House during his administration as an old neighbor and acquaintance. His duties are to keep a close watch of any attempt to obtain by stealth any of the paper, and he not unfrequently makes the guards a visit at the mill when least expected at night.—*Paper World.*



IROQUOIS, THE WINNER OF THE DERBY.

THE WINNER OF THE DERBY.

IROQUOIS, who has at length succeeded in winning their first Derby for the Americans, is the property of Mr. P. Lorillard, one of the largest owners of racehorses on the other side of the Atlantic. He is by Leamington from Maggie B. B., and his sire, who has already been more than creditably represented in this country by old Parole, was himself a racehorse of very high character, and was imported from England when he was twelve years old. Iroquois, who is rather on the small side, standing a shade under 15 hands 3 inches, is a brown colt, with a narrow blaze on the face, and a little white on the near fore heel. He has a good head, and his neck, though a trifle light, is well set on. Perhaps his strongest point is his shoulders, which are unusually deep and well placed. On the other hand, he is undoubtedly light in the flank, and his quarters, though very muscular, are by no means of the massive order. His feet are as good as they can be; and his legs, which are thoroughly well shaped, sound, and free from blemish, must be made of iron to stand the "heroic" style of training practiced by Pincus, who prepared him for all his engagements this season. His two-year-old career was of a very checkered description. He came out with a great reputation at the Newmarket Second Spring Meeting, and won the Two-Year-Old Plate very easily from Herman, Kühleborn, and three others. In his next three essays, however, he was only once successful, and on that occasion he only had a solitary and very moderate opponent. At the Newmarket July Meeting he fairly astonished every one by running the peerless Bal Gal to a head in the July Stakes, and cantering away with the Chesterfield Stakes on the following day. These two fine performances were followed by a wretched exhibition at Sandown Park. His next appearance was at Goodwood, where he won the Lavant Stakes from Isola Madre and others; but Wandering Nun cut him down without an effort in the Findon Stakes, and he could not even gain a place in any of his last three races. This year he has been out three times, running second for the Two Thousand Guineas, cutting down Lennoxlove for the Newmarket Stakes, and walking over for the Burwell Stakes. While admitting that Iroquois met a moderate field in the Derby, we do not at all wish to deprive him of any of the credit of his victory, as he must be one of the hardiest and soundest horses ever foaled, and might have been "made to order" for the peculiar Epsom course. He has many valuable engagements, including one in the St. Leger, in which race we hope to see him play the third and deciding game of the rubber with Peregrine.—*Illustrated London News.*

SECONDARY BATTERY OF M. C. FAURE.

By E. REYNIER.

THIS battery is derived from that of Planté; its electrodes are of lead, and are plunged into water acidulated with sulphuric acid, but its formation is deeper and more rapid. In the Planté battery the formation is limited by the thickness of the sheets of lead. M. Faure gives quickly to his elements an almost unlimited power of accumulation by covering the electrodes with a layer of spongy lead. The two lead plates of an element are individually covered with red lead or some other insoluble oxide of lead. They are then inclosed in compartments of felt, kept firmly in their places by lead rivets, and the two electrodes are then placed, the one close to the other, in a receptacle containing acidulated water. The element is then traversed by an electric current, which brings the red lead to the state of peroxide upon the positive electrode, and reduces it to metallic lead upon the negative electrode.

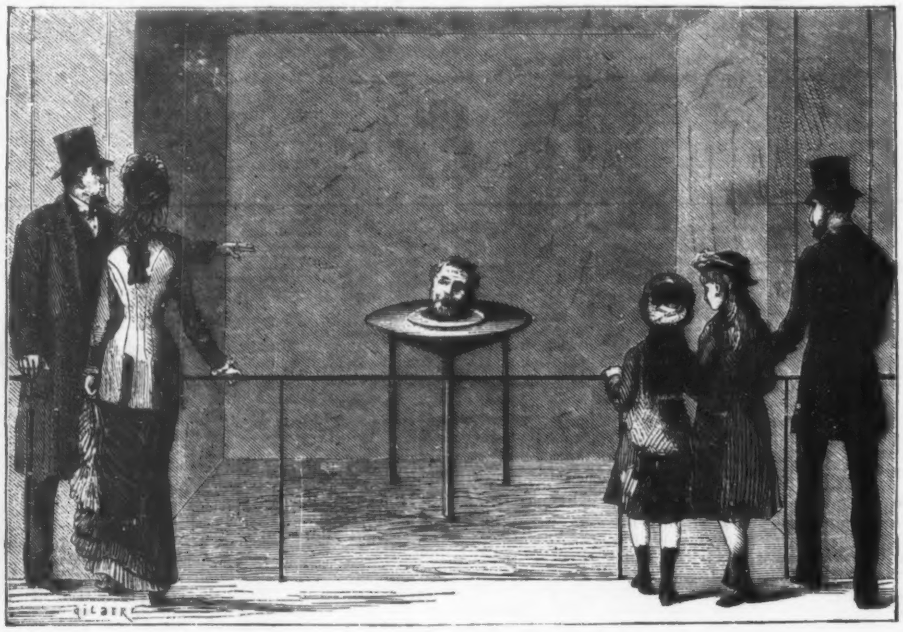
When the mass has been electrolyzed, the couple is formed and charged. When discharged, the reduced lead is oxidized, and the peroxide of lead is reduced until the element becomes inert. It is then in condition to receive a new electric discharge. A quantity of energy capable of performing the work of one-horse power may thus be stored up for an hour in a Faure's battery of 75 kilos.

ACTION OF ELECTROLYSIS UPON TOLUENE.—From pure toluene the author obtains a brown amorphous deliquescent body possessing all the properties of phenose. If the toluene submitted to electrolysis contains benzine, the phenose is accompanied by benzo-glycol. —*A. Renard.*

AMONG the new discoveries made within the past few months is a large body of asbestos. This was discovered by Mr. T. B. Leavenworth, about six miles from Deadwood City. The croppings can be traced for nearly three hundred feet, while a large body of it has already been unearthed. Tests have been made which prove that this body of asbestos is equal to any yet discovered in America. It may be that this mineral will not come into immediate use, adds the *Pioneer*, but the day is not far distant when it will become an article of export from the Hills.

THE MAGIC CABINET.

MANY ingenious illusions have been contrived, depending on the laws of reflection from plane surfaces. Among these is the well known one devised for theaters by the physicist Robin, and which at one time attracted great attention under the name of "Pepper's Ghost." This spectral illusion is produced by reflections from a large sheet of unsilvered plate glass, which is so arranged that the actors on the stage are seen through it, while other actors placed in strong illumination, and out of direct view of the spectators, are seen by reflections in it, and appear as ghosts on the stage. But one of the most striking applications of mirrors for the amusement of an audience in undoubtedly that seen in the contrivance represented in the annexed figure and known as the *magic cabinet*. Some years ago an exhibition of this kind drew large audiences of curiosity seekers to witness it, both in Paris and in a large number of other cities. The visitor, on gazing into a small cabinet, which no one was allowed to enter, saw a small three-legged table, on which lay a large plate containing a human head. This head, which was apparently that of a decapitated person, moved its eyes, made grimaces, and talked. Although the spectators believed that they saw an empty space beneath the table, the individual to whom the head belonged was really seated there, his body being hidden by two vertical glass mirrors fitted between the legs of the table at an angle of 45 degrees with the two side walls. The whole was so arranged that these two walls coincided with the visible portions of the wall in the rear of the cabinet. The three walls were painted of a homogeneous color, and the illusion being enhanced by the feeble light employed, the effect was very remarkable. Had some spectator, however, thrown a stone between the legs of the table, a crash of glass would have followed and at once have unveiled the mystery.—*La Nature.*



THE MAGIC CABINET.

THE DEVIOSCOPE.

APPARATUS FOR GIVING DIRECTLY THE RELATION THAT EXISTS BETWEEN THE ANGULAR VELOCITY OF THE EARTH AND THAT OF ANY HORIZON WHATEVER AROUND THE VERTICAL OF THE PLACE.*

FOUCAULT was the first to formulate that the apparent rotation of the plane of the oscillation of the pendulum is proportional to the sinus of the latitude, or, in other words, that the angular displacement of the plane of oscillation is equal to the angular motion of the earth in the same time, multiplied by the sinus of the latitude of the place of observation. In our hemisphere this displacement occurs toward the left hand of the observer who is facing the pendulum; but in the southern hemisphere it takes place toward the right.

If, then, we designate by n the uniform rotation of the earth, the rotation around a vertical, at a latitude λ, will be $n \sin \lambda$. In a second of sidereal time this rotation is 15" $\sin \lambda$, the uniform rotation of the earth being 15" per sidereal hour.

Foucault arrived at the discovery of this law by the aid of an ingenious hypothesis, which consists in admitting that, when the vertical that is always included within the plane of oscillation changes direction in space, the successive positions of the plane of oscillation are determined by the condition of making minima angles among them. To state this in more popular language: when the vertical departs from the plane of the original impulsion the plane of oscillation follows it, remaining as parallel as possible.

The accuracy of this law of the sinus of latitude has been confirmed in all places where the famous experiment of Foucault has been repeated; but nowhere has it been demonstrated more brilliantly than it was at the Pantheon in 1851.

The verification of the law in question by the aid of the pendulum requires, however, numerous experiments to be made at different latitudes. Now the impossibility of making such a verification without traveling about, and the difficulty of performing the experiment in a course of physics, have led some scientists to devise instruments which would show, artificially and on the spot, what in reality takes place at different latitudes. Among such apparatus may be mentioned those of Wheatstone and Silvestre.

The apparatus which I have constructed for the same purpose is more complete than any that have preceded it; and it permits of the law in question being verified very simply, inasmuch as the arrangement adopted is a faithful mechanical realization of Foucault's hypothesis.

In the accompanying Figs. 1, 2, and 3 my instrument is represented in three different positions, these corresponding with the pendulum experiment as performed at the pole, at the equator, and at a mean latitude. It consists (Fig. 1.) of a cast-iron tripod, P, surmounted by a steel standard, which supports a sphere made of metal or hard wood. In all the experiments, this sphere remains fixed. A curved arm, *m m*, serves as a support to a small system of gearing composed of three wheels, A, B, and C. The sphere and these three wheels have exactly the same diameter.

The wheel, A, is secured on a steel axle, upon the prolongation of which is represented, by two little brass balls, the plane of oscillation of an imaginary pendulum. This little pendulum may be fixed at the different latitudes of the sphere by displacing the system of gearing by means of a hinge-joint located in the center of the curved support, *m m;* its axis, prolonged by the imagination, ends at the center of the sphere. At the upper part of the curved arm there is an index which moves over the divided circle, *d*, thus permitting of the pendulum being placed exactly at any latitude whatever. In this way the vertical of the pendulum may be displaced at will according to any like meridian of the central sphere. The wheels, A and B, are toothed and gear with each other. As for the wheel, C, which is on the same axle with B, it is in reality only a roller having a finely toothed rim, and being designed to roll over the sphere *without sliding* when the arm, *m m*, is made to revolve around the vertical axis of the instrument in the direction of the earth's rotation. Now it is clear that in this rotation the roller, C, will carry along the wheel, B (since these two parts are mounted on the same axle), always parallel with the vertical of the place of observation; and, consequently, the wheel, B, will impel the wheel, A, with a velocity equal to its own, but in an opposite direction. On the other hand, as the axle of the wheel, A, in Fig. 1, is placed on the prolongation of the vertical diameter of the sphere representing the terrestrial axis, while the roller, C, moves over the equator of this same sphere, it results that the plane of oscillation of the pendulum remains strictly fixed with respect to surrounding objects.

From this fixedness it is readily deduced, by the aid of a graduated dial, *b*, representing a polar horizon fixed to the revolving support, and by a needle located in the plane of oscillation, that this plane seems to displace itself in a direction opposite to the rotation of the support. Thus may be verified the fact that at the pole, the displacement of the plane of the pendulum's oscillation is equal to the angular motion of the earth, but of an opposite direction, and that this displacement takes place toward the left of the observer who is facing the pendulum. In order to verify what occurs at the terrestrial equator, the apparatus is arranged as shown in Fig. 2. It is then seen that the point of contact of the roller, C, is exactly at the pole of the sphere, and, consequently, that the displacement of the whole system around the vertical of the apparatus can produce no angular rotation of the roller around its axle, and the same is the case with respect to the wheels, B and A. Thus may be demonstrated the fact that, at the equator, the plane of the pendulum's oscillation undergoes no angular displacement around the vertical, whatever be the azimuth of the plane.

Finally, as regards the pendulum experiment executed at a mean latitude, the apparatus must be arranged as shown in Fig. 3. In this arrangement the roller, C, is confined to a movement over a parallel of the sphere whose latitude is equal to the complement of that of the place of observation, and it impels the wheel, A, with an angular velocity $\omega' = \omega \sin \lambda$; ω being its angular displacement on the sphere.

To demonstrate this, let P P' (Fig. 4) be the line of the poles of the sphere, E E' the equator, and λ the latitude of the place.

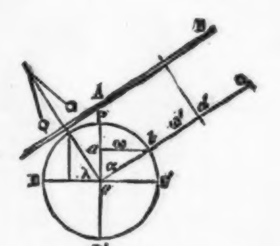


Fig. 4.

On causing the system of wheels to revolve around the vertical of the apparatus, it is easily seen that the distances passed over by the point of contact, *b*, on the circumference of the roller, C, and on the parallel circle with the radius, *a b*, are respectively $\omega' \times b\,d$ and $\omega \times a\,b$.

Now these spaces passed over are equal, since the roller, C, moves over the sphere without sliding. We have, then,

$$\omega' = \omega \frac{a\,b}{b\,d} \qquad (1.)$$

A simple discussion of this elementary formula shows that:

1.—When the experiment is made at the pole, as in Fig. 1, $a\,b$ becomes equal to $o\,E' = b\,d$; consequently $\omega' = \omega$.

2.—In the case of the equator (Fig. 2) $a\,b$ is nil, and ω' is also nil.

3.—Finally, in the case of Fig. 3; as by construction $b\,d = o\,b$, formula 1 becomes

$$\omega' = \omega \frac{a\,b}{o\,b} = \omega \sin$$

or, $$\omega' = \omega \sin \lambda, \text{ Q. E. D.}$$

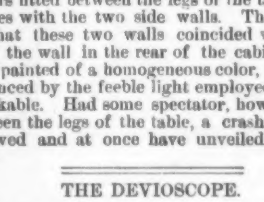


Fig. 1.

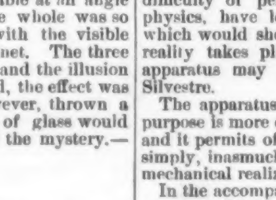


Fig. 2.

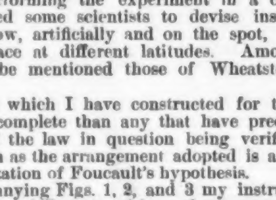


Fig. 3.

THE DEVIOSCOPE SHOWN IN THREE POSITIONS.

* George Sire in *La Nature.*

TELE-PHOTOGRAPHY.

WHILE experimenting with the photophone it occurred to me that the fact that the resistance of crystalline selenium varies with the intensity of the light falling upon it might be applied in the construction of an instrument for the electrical transmission of pictures of natural objects in the manner to be described in this paper.

In order to ascertain whether my ideas may be carried out in practice, I undertook a series of experiments, and these were attended with so much success that although the pictures hitherto actually transmitted are of a very rudimentary character, I think there can be little doubt that if it were worth while to go to further expense and trouble in elaborating the apparatus excellent results might be obtained.

The nature of the process may be gathered from the following account of my first experiment. To the negative (zinc) pole of a battery was connected a flat sheet of brass, and to the positive pole a piece of stout platinum wire; a galvanometer was interposed between the battery and the brass, and a set of resistance-coils between the battery and the platinum wire (see Fig. 1, where B is the battery, R the resistance, P the wire, M the brass plate, and G the galvanometer) A sheet of paper which had been soaked in a solution of potassium iodide was laid upon the brass, and one end of the platinum wire previously ground to a blunt point was drawn over its surface. The path of the point across the paper was marked by a brown line, due, of course, to the liberation of iodine. When the resistance was made

small this line was dark and heavy; when the resistance was great the line was faint and fine; and when the circuit was broken the point made no mark at all. If we drew a series of these brown lines parallel to one another, and very close together, it is evident that by regulating their intensity and introducing gaps in the proper places any design or picture might be represented. This is the system adopted in Bakewell's well-known copying telegraph. To ascertain if the intensity of the lines could be varied by the action of light, I used a second battery and one of my selenium cells, made as described in *Nature*, vol. xxiii., p. 58. These were arranged as shown in Fig. 1, the *negative* pole of the second battery, B′, being connected through the selenium cell, S, with the platinum wire, P, and the positive pole with the galvanometer, G. The platinum point being pressed firmly upon the sensitized paper and the selenium exposed to a strong light, the resistance, R, was varied until the galvanometer needle came to rest at zero. If the two batteries were similar this would occur when the resistance of R was made about equal to that of the selenium cell in the light. The point now made no mark when drawn over the paper. The selenium cell was then darkened, and the point immediately traced a strong brown line; a feeble light was next thrown upon the selenium, and the intensity of the line became at

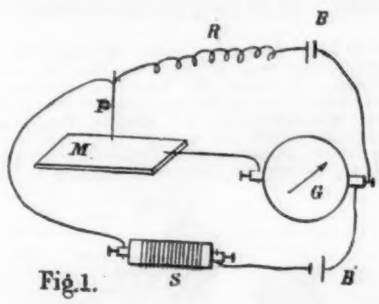


Fig.1.

once diminished. Lastly, a screen of black paper, having a large pin hole in the middle, was placed at a short distance before the selenium, and the image of a gas flame was focused upon the outer surface of the screen, a small portion of the light passing through the pin hole and forming a luminous disk upon the selenium. The galvanometer was was again brought to zero, and, as before, the platinum point made no mark. When, however, the gas flame was shaded a firm and steady line could be drawn; and when the light was interrupted by moving the fingers before the pin hole a broken line was produced. For this last operation a very sensitive paper was required, and it was found necessary to move the platinum point slowly.

In consequence of the very satisfactory results of these preliminary experiments I made a pair of "telephotographic" instruments, of which the receiver was slightly modified from Bakewell's form. They are of rude construction, and I shall say nothing more about them except that on January 5 they produced a "telephotograph" of a gas flame, which was good enough to induce me to make the more perfect apparatus now to be described.

The transmitting instrument consists of a cylindrical brass box four inches in diameter and two inches deep, mounted axially upon a brass spindle seven inches long, and insulated from it by boxwood rings. The spindle is divided in the middle, its two halves being rigidly connected

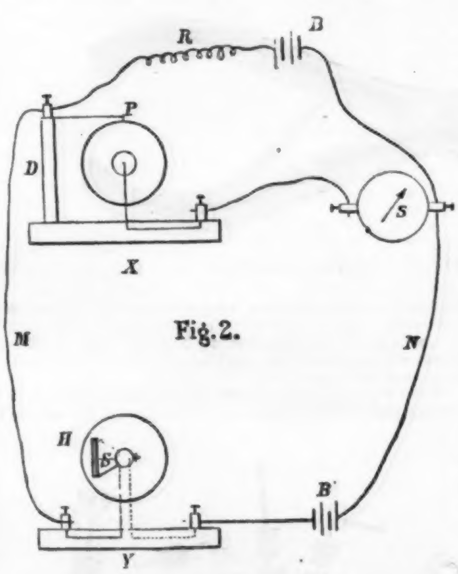


Fig.2.

together by an insulating joint of boxwood. One of the projecting ends of the spindle has a screw cut upon it of sixty-four threads to the inch; the other end is left plain. The spindle revolves, like that of a phonograph, in two brass bearings, the distance between which is equal to twice the length of the cylinder; and one of the bearings has an inside screw corresponding to that upon the spindle. At a point midway between the two ends of the cylinder a hole a quarter of an inch in diameter is drilled, and behind this hole is fixed a selenium cell, the two terminals of which are connected respectively with the two halves of the spindle. The bearings in which the spindle turns are joined by copper wires to two binding screws on the stand of the instrument. The transmitter thus described is represented in diagrammatic section at Y (Fig. 2), where H is the hole in the cylinder, and S the selenium cell.

The receiving instrument, shown at X (Fig. 2), contains another cylinder similar to that of the transmitter, and mounted upon a similar spindle, which, however, is not divided, nor insulated from the cylinder. An upright pillar, D, fixed midway between the two bearings, and slightly higher than the cylinder, carries an elastic brass arm fitted with a platinum point, P, which presses normally upon the surface of the cylinder. To the brass arm a binding screw is attached, and a second binding screw in the stand is joined by a wire to one of the brass bearings.

To prepare the instruments for work they are joined up as shown in Fig. 2, two batteries, a set of resistance coils, and a galvanometer being used, in exactly the same manner as in the preliminary experiments. The cylinder of the transmitting instrument, Y, is brought to its middle position, and a picture not more than two inches square is focused upon its surface by the lens, L. The pictures upon which I have operated have been mostly simple geometrical designs cut out of tin foil and projected by a magic lantern. It is convenient to cover a portion of the cylinder with white paper to receive the image. The comparatively large opening, H, is covered with a piece of tin foil, in which is pricked a hole which should be only just large enough to allow the instrument to work. [I have not been able to reduce it below one-twentieth of an inch, but with a more sensitive selenium cell it might with advantage be smaller.] The hole is then brought, by turning round the cylinder, to the brightest point of the picture, and a scrap of sensitized paper, in the same condition as that to be used, being placed under the point, P, of the receiver, the resistance, R, is adjusted so as to bring the galvanometer to zero. When this is accomplished the two cylinders are screwed back as far as they will go,

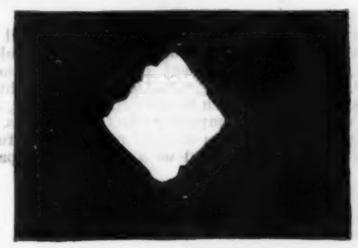


FIG. 3.—IMAGE FOCUSED UPON TRANSMITTER.

the cylinder of the receiver is covered with sensitized paper, and all is ready to commence operations.

The two cylinders are caused to rotate slowly and synchronously. The pin-hole at H in the course of its spiral path will cover successively every point of the picture focused upon the cylinder, and the amount of light falling at any moment upon the selenium cell will be proportional to the illumination of that particular spot of the projected picture which for the time being is occupied by the pin-hole. During the greater part of each revolution the point, P, will trace a uniform brown line; but when H happens to be passing over a bright part of the picture this line is enfeebled or broken. The spiral traced by the point is so close as to produce at a little distance the appearance of a uniformly colored surface, and the breaks in the continuity of the line constitute a picture which, if the instrument were perfect, would be a monochromatic counterpart of that projected upon the transmitter.

An example of the performance of my instrument is shown in Fig. 4, which is a very accurate representation of the manner in which a stencil of the form of Fig. 3 is reproduced when projected by a lantern upon the transmitter. I have not been able to send one of its actual productions to the engraver, for the reason that they are exceedingly evanescent. In order to render the paper sufficiently sensitive, it must be prepared with a very strong solution (equal parts of iodine and water), and when this is used the brown marks disappear completely in less than two hours after their formation. There is little doubt that a solution might be discovered which would give permanent results with equal or even greater sensitiveness, and it seems reasonable to suppose that some of the unstable compounds used in photography might be found suitable; but my efforts in this direction have not yet been successful.

In case any one should wish to repeat the experiments here described a few practical hints may be useful. In order that as large a portion as possible of the current from the battery, B′ (which is varied by the selenium cell), may pass

FIG. 4.—IMAGE AS REPRODUCED BY RECEIVER.

through the sensitized paper, the resistance, R, must be high; the EMF. of the battery, B, must therefore be great, and several cells should be used.

An electromotive force is produced by the action of the platinum point and the metal cylinder upon the sensitized paper, and the resulting current is for many reasons very annoying. I have got rid of this by coating the surface of the cylinder with platinum foil.

Stains are apt to appear upon the under surface of the paper, which sometimes penetrate through and spoil the picture. They may be prevented by washing the surface of the cylinder occasionally with a solution of ammonia.

Slow rotation is essential in order both that the decomposition may be properly effected and that the selenium may have time to change its resistance. The photophone shows that *some* alteration takes place almost instantaneously with a variation of the light, but for the greater part of the change a very appreciable period of time is required.

The distance between the two instruments might be a hundred miles or more, one of the wires, M, N, being replaced by the earth, and for practical use the two cylinders would be driven by clockwork, synchronized by an electro-magnetic arrangement. For experimental purposes it is sufficient to connect the two spindles by a kind of Hooke's joint (some part of which must be an insulator), and drive one of them with a winch handle.

The instrument might be greatly improved by the use of two, four, or six selenium cells and a corresponding number of points. If two such cells were used the transmitting cylinder would have two holes, diametrically opposite to each other, with a selenium cell behind each. A second point would press upon the under surface of the receiving cylinder, and be so adjusted that the lines traced by it would come midway between those traced by the upper point. Four or six selenium cells could be similarly used. The adjacent lines of the picture might thus be made absolutely to touch each other, and, moreover, the screw upon the spindles might be coarser, which for obvious reasons would be advantageous. A self-acting switch or commutator in each instrument would render additional line wires unnecessary.—*Shelford Bidwell, in Nature.*

DETERMINATION OF PHOSPHORIC ACID.

By Dr. Brunner.

A summary of the principal points in Dr. Petermann's method, the so-called Belgian commercial process. The ammonium citrate is prepared by dissolving citric acid in ammonia, so that the liquid may have a decided but not too powerful ammoniacal reaction. It is diluted to sp. gr. 1·09, filtered, and preserved in well-stoppered bottles. The quantity of the sample operated upon may be: of mixed manures, ammoniacal superphosphates, etc., 10 grms., superphosphates, 5, and precipitated phosphates, 2. 100 c.c. of the citrate are put in a small washing-bottle, and the weighed quantity of manure is washed with a slight stream into a small porcelain mortar; it is lightly rubbed up with the pestle, and gradually elutriated into a 500 c.c. flask, rinsing with the washing-bottle till the 100 c.c. are consumed. As little water as possible should be used in addition. The flask and its contents are next heated to 35° in the water-bath for exactly an hour, with occasional shaking; then filled up to the mark, mixed by repeated inversion, and filtered. The liquid which first passes is always turbid, and only the subsequent portion, when perfectly bright, should be taken for analysis. 50 or 100 c.c. of the clear filtrate are then precipitated with a sufficient quantity of magnesium chloride solution, well stirred, made strongly ammoniacal, and filtered after standing for six hours. After washing with ammonia, the precipitate is ignited in the usual manner, and weighed as magnesium pyrophosphate. If the quantity of phosphoric acid soluble in water is required it must be determined in a fresh portion. It is remarkable that in the analysis of certain very rich superphosphates the total phosphoric acid, as determined gravimetrically by the molybdenum process, was repeatedly found lower than the assimilable phosphoric acid.

DETERMINATION OF PHOSPHORIC ACID.

By Carl Mohr.

The author proposes the following process: 2 or 5 grms. of the finely-powdered mineral are repeatedly boiled with small quantities of dilute nitric acid; the liquids are mixed in a measuring flask containing 100 or 250 c.c., and when cold filled up to the mark. In case of superphosphate similar proportions are observed, but distilled water is used instead of nitric acid. 10 or 25 c.c. of the filtrate are mixed with a solution of sodium acetate till a permanent turbidity is produced. The solution of uranium acetate is then allowed to flow in, heating gently at first, and afterward to a boil, and before the precipitation is at an end a few granules of potassium ferrocyanide are added. The ferric phosphate is decomposed, the phosphoric acid enters into solution, the ferric oxide becomes Prussian blue and mixes with the uranium phosphate. The complete transformation of the ferric oxide into Prussian blue is ascertained when a drop of the clear liquid upon a porcelain plate shows no further coloration with ferrocyanide. The hot liquid very rapidly deposits the suspended precipitate. The author presses the rounded end of a moist thin glass rod upon ferrocyanide in a dry powder, when so much clings to the glass as to be sufficient for 10 c.c. of a mineral containing a slight amount of iron. It is important to defer the further addition of the uranium solution till all the ferric-oxide is transformed. The addition of the uranium solution is then continued till the known coloration with potassium ferrocyanide indicates the end of the process. The first drop of uranium solution should not occasion a red coloration where it falls. If this happens, a new portion must be taken, and the operation repeated. As in the ordinary process of titrating phosphoric acid with uranium, the solution is rarely absolutely free from iron, the final reaction disappears after it has been already produced—a circumstance which often leaves the analyst in doubt to the extent of entire c.c. This disappearance of the final reaction may be avoided by the careful application of the method described above.

RED LEAD.

By Friedrich Lux.

The author places 2·07 grms. of the sample in a porcelain dish holding about 300 c.c., and adds 20 to 30 c.c. dilute nitric acid, heating gently, and stirring. In a few minutes the red-lead is resolved into lead oxide, which dissolves, and peroxide, which is insoluble. He then adds 50 c.c. of a one-fifth normal solution of oxalic acid, and heats to a boil. The peroxide is decomposed and dissolved, and the nature of the liquid shows to a certain extent the quality of the sample. Heavy spar, lead sulphate, clay, iron oxide, and gypsum in large quantities appear as a turbidity or a sediment, while if the red-lead is pure a perfectly clear and colorless solution is obtained. The liquid is kept at a boil, and the excess of oxalic acid is determined with one-fifth normal permanganate, accurately standardized with solution of oxalic acid. The number of c.c. of permanganate consumed is deducted from 50, and the difference shows the percentage of lead present as peroxide. As not more than 30·21 per cent. of lead can be present as peroxide, and consequently 19·79 c.c. of solution of oxalic acid must remain undecomposed, 5 to 10 c.c. of permanganate are added at once, and are immediately decolorized. Toward the end the decolorization is slower, and the operation may be regarded as complete when the rose color produced by two drops of permanganate does not disappear in half a minute. After the liquid has been rendered colorless by boiling for a few minutes, it is nearly neutralized with ammonia, mixed with a sufficient quantity of ammonium acetate, and titrated in the usual manner with solution of bichromate, 14·761 grms. per liter. The number of c.c. consumed gives the total percentage of lead. If the quantity of lead present as peroxide is deducted from the total, the lead existing as oxide is found, and the composition of the sample is known.

PHOSPHORUS IN POISONING.

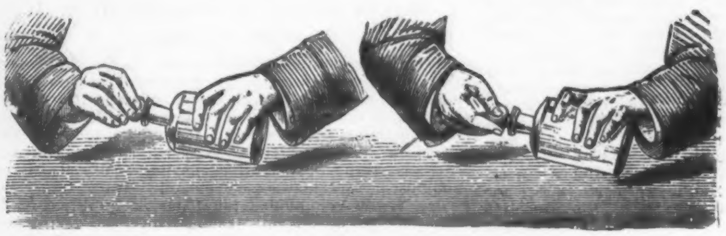
By L. Medicus.

In the case of a hen poisoned with phosphorus the digestive organs were found luminous on the twenty-third day after death, and phosphorus was readily detected.

MANIPULATION OF CHEMICAL APPARATUS.—STOPPERS.

Translated from the German, by M. BENJAMIN, Ph.B., F.C.S.

1. *Glass Stoppers*.—Must be perfectly ground. This is ascertained by wetting them and pushing them into the neck of the bottle; if they shake, they have been improperly ground, and should be rejected. In many cases, however, the difficulty is overcome by grinding them in with a little emery or oxide of iron, by turning the stopper in a particular manner. The bottle is held in the left hand, and the stopper, which has been covered with the wet emery or oxide of iron, in the right, is gently pressed into the neck of the bottle and turned 90° to the left (Fig. 1), then is slightly withdrawn and again pressed in and turned 90° to the right (Fig. 2). In this manner it is alternately turned to the right and left, observing the precaution to lift it out each time before turning. It is essential that the stopper should receive a twofold motion—first a pushing motion into the neck; and, second, a revolving motion alternately right and left. Beginners seem to believe that simple turning will produce the desired result, but this is not so; without the combined motion no progress is made.



FIGS. 1 AND 2.—GRINDING IN OF STOPPERS.

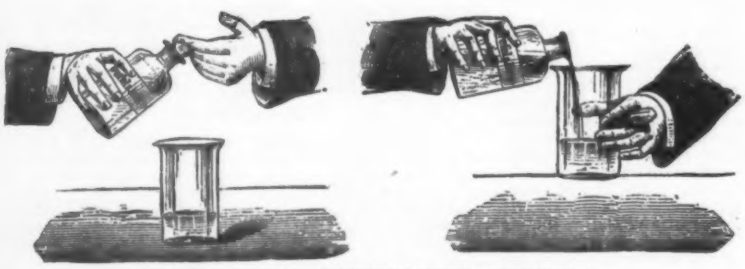
FIGS. 3 AND 4.—REMOVAL OF OBSTINATE GLASS STOPPERS.

The sticking of glass stoppers is often the source of considerable annoyance. This may be overcome by placing the bottle on the table, and holding it as shown in fig. 3; at the same time the stopper is held with the thumb and forefinger and a withdrawing action exerted. Then, with a piece of wood, such as the handle of a file or knife, one gently strikes the sharp edge of the stopper, drawing it out at the same time. If the bottle does not immediately open, the knocking is repeated by striking the other side of the stopper. This is continued until it is clear that the stopper cannot be removed in this manner. Then one tries to loosen the stopper by expanding the neck of the bottle.

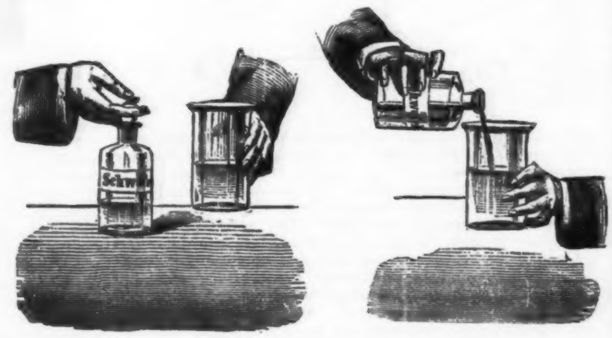
This may be accomplished by two different methods: Either one fastens a strong string to a nail in the wall, and catching hold of the end of the same with the left hand, it is twisted once around the neck of the bottle, and then holding the string tense, the bottle is rapidly moved to and fro. Or the neck of the bottle is held horizontally in the flame of a lamp and rapidly revolved (Fig. 4). Considerable care must be taken in this operation, that the thick part of the bottle does not become heated; for, in case it contains liquids, they would in the continual turning touch the heated portion, and so cause the bottle to break.

The stopper can generally be removed after properly warming the neck. The stopper must not be replaced until the neck has become perfectly cool, otherwise it would sink in too far, and in the subsequent contraction of the neck it would be held so much tighter that the neck might break.

Certain chemicals, such as the caustic alkalies, silico-fluorides, etc., have a decomposing effect on the glass. In such cases, the neck and the stopper must be carefully dried before the latter is inserted or a thin coat of paraffine is applied to the stopper. To prevent the mixing of stoppers, they should be numbered with a diamond, and the same number marked on the bottle.



FIGS. 5 AND 6.—POURING FROM BOTTLES, I.



FIGS. 7 AND 8.—POURING FROM BOTTLES, II.

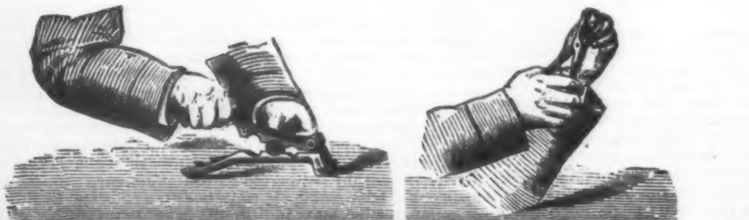
In pouring liquids from glass bottles, when both hands are unoccupied, the bottle is held in the right hand, and with the left the stopper is removed (Fig. 5); then, still retaining the stopper between the fingers of the left hand (Fig. 6), the contents are poured out and the last drop carefully removed with the stopper, thus preventing the liquid from running down along the outside of the bottle, which must always be held in such a manner that the hand covers the label and the liquid is poured out on the opposite side, in order to prevent the liquid from running over the rim and spoiling the label. In pouring a liquid from the bottle into a convenient vessel, the latter is held in the left hand (Fig. 7), and then the stopper is removed with the fore and middle fingers of the right hand from the bottle. This accomplished, the hand is at liberty to hold the bottle.

The contents are then poured out, and the last drop is removed, as has been described. By careful adherence to these details it is possible to avoid the necessity of placing the stopper on the table while the liquid is being poured out, and so it is not soiled or contaminated with impurities and the reagents are kept pure.

2. *Cork Stoppers*.—These must be carefully selected from uniform material, which should not be soft or porous. Their form should be cylindrical. In their impressed state they should have a circumference somewhat larger than that of the opening into which they are to be introduced; but the difference should not be too great, otherwise they would be compressed beyond their limit of elasticity and then they would no longer fit tightly. Before the stopper is inserted, they are pressed with a cork press (Fig. 9), or (smaller corks) with cork pincers (Fig. 10), so that they may become soft and flexible, and readily accommodate themselves to the openings for which they are designed (Figs. 11 and 12). Apparatus fitted with cork stoppers, which are rarely used and so remain unemployed for a long while, should be unstoppered; for the long-continued pressure to which the corks would be exposed would make them too thin and they would lose their elasticity.

FIG. 9.—CORK PRESS.

FIG. 10.—CORK PINCERS.



FIGS. 11 AND 12.—PRESSING CORKS.

In such cases the cork is fastened by some other method to apparatus, in order that it may not be lost (Fig. 13). This is especially desirable for gas-developing flasks which are but seldom used.

FIG. 13.—PRESERVATION OF CORKED VESSELS.

Holes are made through corks by means of cork borers. These consist of a series of brass (occasionally tin) tubes inserted one into the other, each of which is provided at one end with a handle, and the other has a sharpened edge. If a tube is to be introduced into a cork, the width of the tube is exactly measured, and that borer is chosen which has the next smallest diameter.

Then the sharp end of the borer is placed vertically at the proper point on the surface of the cork, and by careful and patient turning to the right pierce the stopper. Care must be taken that the boring does not proceed in an inclined direction (Fig. 14). This can generally be determined by feeling the end.

Some experience is necessary for the proper accomplishment of this operation. When the borer has almost pierced the cork, another (old) cork is placed against the end, and

the boring completed. Then, by the insertion of the rod, the contents of the tube are pushed out and the borer withdrawn. Both rims of the hole must be round and smooth. The opening in the cork is, when necessary, cleaned and widened by means of round files, several sizes of which one should possess. It is more difficult to bore two or more holes in the same cork and to have them exactly parallel. After the first hole has been bored as straight as possible, the borer is placed with the right hand at the position where the second hole is to be made, then closing the two rims of the first hole with the thumb and forefinger of the left hand, the cork is pierced in the same way as is shown in Fig. 15. After the borer has been pushed in a little ways, the operation is stopped for a few minutes till one convinces himself that the borer has been placed in the proper position. Then the boring proceeds, but care must be taken that the borer is not pressed over toward one side or the other. The most reliable guide is the feeling in the hand, and this comes with practice.

When the cork borers have become dull from use, they must be sharpened. This is readily performed by filing, with the flat side of a triangular file, around the exterior of the opening (Fig. 16 *a*), and then removing the portions which have been bent inward by means of the lower end of the file (Fig. 16 *b*). Both of these operations are alternately repeated until a sufficient degree of sharpness has been obtained. It is best to fuse the ends of glass tubes which are to be inserted into the corks; they must not fit too loosely. And, on the contrary, when they fit too tightly, they must be moisted with a little water or oil and continually turned, always in the same direction while they are being inserted (Fig. 17). At the same time care is to be taken that one does not press the tubes in too strongly, for the tube may break and the piece which remains in the cork will run into the hand and inflict severe injuries.

For the cutting of corks any ordinary well-sharpened knife will answer. It is only necessary to let it act by drawing across the cork rather than by pressing. One practices this operation by trying to reduce the thickness of a cork by removing as thin a film as it is possible. The knife is held as shown in Fig. 18; and while pressing it it is repeated, drawn toward the wrist. Previous to cutting, the cork should be softened by a gentle pressing.

Larger corks may be reduced in size (to the desired shape) by filing. A cork file has a rough, rasp-like side, and a finer side. One begins by using the former, ending off with the latter. It must be freed from time to time by removing the adhering particles of corks so that it may be better adapted to attack the cork.

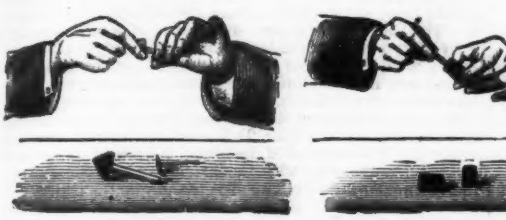
Large corks are seldom sufficiently free from pores as to be gas tight. They may be made so by treatment with paraffine. To accomplish this the paraffine is melted at a gentle heat, and the cork placed in the molten mass for some time; it is loaded or attached to a weight so that it will be kept under the surface of the liquid. On taking the cork out of the bath it is well dried with a piece of cloth, and inserted, while still warm, into the opening for which it is intended. Should the orifice be too narrow, the slipperiness of the paraffine and the elasticity of the cork will make it slip out. If it cannot be fastened in by tying, etc., the outer surface of the cork is rubbed with finely pulverized chalk, which will, in most cases, make it retain its hold.

Corks belonging to apparatus from which they are seldom removed, as, for instance, calcium chloride tubes, are pushed away into the tube, or, when this is impracticable, they are cut off even with the end of the tube. The outer surface of the cork and the rim of the glass are then coated with fused sealing wax mixed with alcohol.

Sometimes it is desirable to fasten a cork by means of a cord or wire. In such a case the string is folded in the shape of a loop, as is shown in Fig. 19, which is brought over the cork, and the ends of the string are drawn together under the rim of the bottle (Fig. 20), and then tied in a solid double knot on top of the bottle. When wire is used a loop is made similar to the one shown in the cut (Fig. 21). The middle portion of the wire is twisted together below the rim of the bottle, and the operation completed by passing the open ends through the loop on top of the cork and bending them back.

3. *Rubber Stoppers.*—These are much more desirable than ordinary cork stoppers for many purposes. They will remain tight for a longer period of time; on account of their greater elasticity they can be (comparatively) more compressed without becoming leaky. Hence they are to be preferred in all cases where vessels are to remain closed for a long time, such as evolution flasks and the like. For their perforation the ordinary cork borers are used, but they must previously be dipped in potassium hydrate (caustic potash).* It is necessary in this operation to be cautious in the use of the caustic alkali, for it may by careless handling get in under the finger nails and lead to very painful sores, which are not noticed at first and only develop later. Of course, rubber stoppers must not be used in cases where they would be brought in contact with substances which would have a dissolving effect in them, such as essential oils, carbon disulphide, ethers, etc. They resist the action of acid quite well. Evolution flasks in which chlorine and nitrous acid are developed may be stoppered with rubber corks. While they may be attacked somewhat, still they may be considered preferable to ordinary corks.

June 4, 1881.



FIGS. 14 AND 15.—BORING OF CORKS.

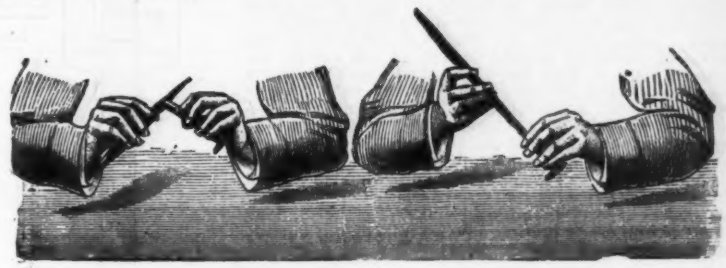


FIG. 16.—SHARPENING OF CORK BORERS.

FIG. 17.—INSERTING TUBES.

FIG. 18.—CORK CUTTING.

FIGS. 19-21.—FASTENING OF CORK STOPPERS.

* Ammonium hydrate may also be used with advantage.—TRANS.

SULPHUROUS AND SULPHURIC ACIDS.

ONLY two compounds of sulphur with oxygen are known in the free state, viz., sulphur dioxide, SO_2, and sulphur trioxide, SO_3. These oxides respectively form with water two well-known acids, viz., sulphurous acid and sulphuric acid. There are, in addition, a series of six other oxy acids of sulphur:

Sulphur Dioxide, or Sulphurous Acid. Symbol SO_2.—When sulphur is burned, a gas is produced which possesses a very characteristic odor; this smell is often described as that of burning sulphur, but this is so far incorrect, for it is due not to the sulphur by itself, but to this compound of sulphur with oxygen. Sulphurous dioxide may be prepared for experimental purposes in a variety of ways, but always by removing a portion of the oxygen from sulphuric acid. When sulphuric acid is boiled with some copper turnings, sulphur dioxide is evolved with great rapidity and regularity. A cheaper way of preparing sulphur dioxide is to boil sulphuric acid with some charcoal, when the latter removes a portion of the oxygen. The sulphur dioxide is then evolved, together with carbonic oxide; the latter, being insoluble in water, escapes, while the sulphur dioxide dissolves and forms a solution of sulphurous acid. Sulphur dioxide may also be produced by boiling sulphuric acid with other deoxidizing agents, and for this purpose cut straw, sugar, and even sulphur itself, have at different times been recommended. Sulphur dioxide is a colorless and invisible gas, having a peculiar irritating odor and taste. It will not support combustion, and being irrespirable, it is injurious and even poisonous to animals. Sulphurous acid condenses into a liquid under a pressure of three atmospheres at the ordinary temperature, or at the normal pressure if the temperature be reduced by means of a freezing mixture of ice and salt. When this liquid sulphur dioxide is rapidly evaporated great cold is produced, which is sufficient to solidify the remaining fluid, and thus white crystals of sulphurous dioxide can be obtained. The liquid sulphurous acid, SO_2, is now prepared on a large scale on the Continent, and is imported into this country in strong hermetically-sealed copper vessels, and is used here for the artificial production of ice.

Sulphur dioxide is very soluble in water, forming then a solution of the true sulphurous acid, H_2SO_3; at the ordinary temperature and pressure, water will dissolve more than forty times its volume of this gas, and this solution forms the sulphurous acid of commerce. The solution is strongly acid, and moreover possesses powerful bleaching properties; this is well observed by placing a colored flower in some of the solution, when in a short time all color will have disappeared. This property of bleaching makes sulphurous acid useful in several industrial arts, and both maltsters and hop-growers have availed themselves of this agent as a means of producing malt and hops of a fine pale color; it is unfortunately too common a practice for sulphur to be thrown in considerable quantities on to the fire under the malt and hops while on the kilns; according to a well-known authority 5 lb. or 6 lb. of sulphur are burned on the fires under each kiln-load of hops, and it is said "the fumes pass quickly up through the drying hops and bleach those that are discolored, and impart a brighter hue to all samples." This practice of bleaching by sulphurous acid, whether applied to malt or hops, ought to be discountenanced by brewers, for it is at best but a rough and ready way of disguising inferiority; the demand by brewers for very pale samples is, however, usually so great that maltsters and hop-growers have no alternative but to make up artificially for the defects of imperfect cultivation and harvesting, and in doing so they call to their aid this striking property of sulphurous acid. This compound is also of great interest to brewers on account of its antiseptic properties; sulphurous acid, both in the free state and in combination with bases, exerts a powerful preservative action; it acts by absorbing oxygen, and therefore is directly opposed to chlorine. Burning sulphur has long been used in wine-growing countries for the purification of the casks and the preservation of the wine; the practice has been to make sulphur matches, and having ignited them to plunge them through the bung-hole of the cask, which is then bunged down and afterwards well shaken, until the sulphurous acid is absorbed; wine-growers have found that this treatment gives strength, sweetness, and durability to wines which lack these qualities; the result of the treatment is often very apparent in this country, where many wines arrive possessing an unmistakable flavor of sulphurous acid. Although a similar treatment was sometimes adopted with brewers' casks, it was not until the late Dr. Medlock took out letters patent for his bisulphite of lime that sulphurous acid was extensively utilized as a preservative and antiseptic in the brewery. Bisulphite of lime is prepared by passing sulphurous acid gas through water containing carbonate of lime in suspension; the gas first dissolves in the water and then acts upon the carbonate, liberating carbonic acid, and forming sulphite of lime, which in its turn dissolves in an excess of sulphurous acid. This most useful preparation, which is so largely employed by brewers, gives us sulphurous acid in a very concentrated and convenient form, and although a portion is in combination with lime, the acids of a decomposing beer are strong enough to liberate the sulphurous acid as it is required. There are some practical objections to the use of bisulphite of lime, which will engage our attention at a later stage of these papers, but when judiciously used there is no doubt it has been a valuable agent in the hands of the brewer. In addition to the bisulphite, there are now many other preparations of sulphurous acid offered to brewers, among which we may enumerate sulphite of magnesia, sulphite of soda, and hydrosulphite of lime, for all of which some distinctive advantages are claimed. A solution of sulphurous acid is also largely used for the cutting of isinglass in the manufacture of finings. This acid is very efficacious for this purpose, and as it effectually prevents the formation of mould and the propagation of injurious organisms, it is superior to sour beer and organic acids, which are also often used. Sulphurous acid combines with nearly all the bases, forming a series of salts called sulphites, which, with the exception of such as we have just referred to, are of no practical interest to brewers.

Sulphur Trioxide, or Anhydrous Sulphuric Acid. Symbol SO_3.—This is by far the most important compound of sulphur, or rather we should say, it is the base of a most important class of compounds. The actual sulphur trioxide is prepared with some difficulty from fuming Nordhausen acid, and occurs at the ordinary temperature in beautiful white feathery crystals, which, however, eagerly absorb moisture from the atmosphere and liquefy. This trioxide is, therefore, only a chemical curiosity, but its combination with water, viz., the sulphuric acid, or oil of vitriol of commerce, is of the greatest importance. This sulphuric acid is prepared on a manufacturing scale by passing sulphurous acid gas, prepared by burning sulphur or iron pyrites in suitable furnaces, into large leaden chambers, where it meets also with a supply of steam and air, and also with a small proportion of nitric oxide gas, which serves by a remarkable reaction to carry an indefinite quantity of oxygen from the air to the sulphurous acid, thus converting it into sulphuric acid; in this way strong sulphuric acid gradually concentrates on the bottom of the leaden chambers, and when drawn off constitutes the oil of vitriol of commerce. It is then a colorless oily liquid having a specific of 1850; it boils at 620° F., and freezes at about [illegible] F. Oil of vitriol has a most extraordinary affinity for water, and will withdraw aqueous vapor from the atmosphere, as well as from many compounds; it has a most powerful corrosive action, and will blacken or char most organic bodies; when added to sugar, or any other member of the large group of bodies called carbohydrates, it removes the element of water and leaves the carbon. Sulphuric acid is a most powerful acid, and possesses the characteristic sour taste to a remarkable degree; it also acts in the usual manner upon litmus paper; it is the strongest of acids, displacing nearly all other acids from their combinations. Sulphuric acid forms a series of salts called the sulphates, many of which are largely employed in various industrial processes. The presence of sulphuric acid in solution, either in a free state or in combination, may be easily detected by means of a solution of chloride of barium, which

at once produces a white precipitate, which is insoluble in the strongest acids.

Of the other compounds formed by sulphur with oxygen and hydrogen, none are of sufficient importance to be studied in these pages; and the same remark applies to the compounds of sulphur with the other elements we have studied; the only exception is a compound of sulphur with hydrogen, to which we propose to devote a few words.

Hydrogen Sulphide, or Sulphureted Hydrogen. Symbol H_2S.—This compound is best prepared by acting upon sulphide of iron with dilute sulphuric acid; it is then liberated in the gaseous state; it is a colorless gas, possessing a most offensive smell, like that of rotten eggs; it burns with a supply of oxygen, forming water and sulphurous acid; it is very poisonous, and is even injurious when diluted with a very considerable proportion of air. Sulphureted hydrogen is soluble in cold water, and the peculiar odor and smell of some mineral waters is due to the presence of this compound. It is a most useful reagent to the chemist, as it forms a series of precipitates with the soluble salts of the various heavy metals, each of which possesses some peculiarity of color or solubility. Sulphureted hydrogen is liberated by the decomposition of organic substances containing sulphur, and in this way the unpleasant smell attending putrefactive changes is developed; the unpleasant smell of rotten eggs is really due to the evolution of small quantities of sulphureted hydrogen derived from the sulphur contained in the albumen of the egg, and this is evidenced by the familiar blackening of a silver spoon placed in such an egg, due to the formation of a film of sulphide of silver. Many sulphates are reduced to sulphides by the action of putrescent organic matters; in this way the unpleasant smell of some beers brewed with very hard water may be accounted for; the hardness of the water is due to sulphate of lime, which salt is gradually decomposed, forming small quantities of a sulphide, which in its turn is by degrees decomposed by the acids contained in the beer, and thus sulphureted hydrogen is liberated. The presence of the minutest trace of sulphureted hydrogen in the air, or any gaseous mixture, may be readily detected by means of a slip of porous paper dipped in a solution of acetate of lead; if any of this gas be present, a brown coloration is immediately produced.—*Brewers' Guardian.*

EXPERIMENTS ON ICE, UNDER LOW PRESSURES.

CERTAIN theoretical considerations on the relations of the solid, liquid, and gaseous states of matter led me three or four years ago to the speculation that in a perfect vacuum the liquid state would be impossible, and that under this condition it might be possible to raise bodies to temperatures above their ordinary melting points. These ideas were mentioned to one or two friends at the time, but they naturally considered them as speculations which would not be verified by experiment. From the pressure of other work the subject was for the time dropped, and it was not till the autumn of 1879 that an experimental investigation was commenced. The first substance tried was sulphur, but this was ultimately found to be unsuitable, as under low pressures, though it apparently boiled as low as 130° C., yet at that or a little above that temperature it began to froth. Naphthalene was then tried, but as the pressure at which the boiling point fell below the melting point was less than about 7 mm., it was not easy to *maintain* the pressure at a sufficiently low point. Mercuric chloride, however, which was the next body tried, yielded better results.

Mercuric chloride melts at 288°, resolidifies at 270°–275°, and boils at 303°. About 40 grammes of the pure compound were placed in the tube A (Fig. 1), and a thermometer ar-

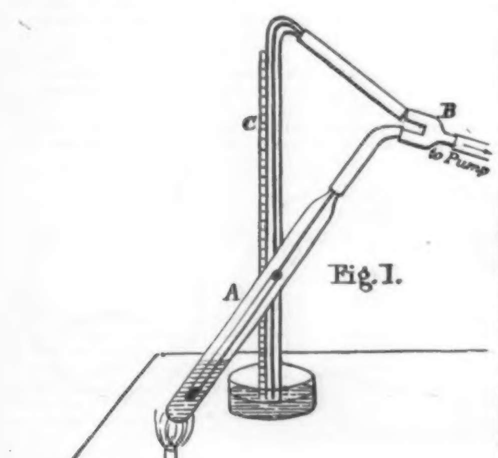


Fig. 1.

ranged with its bulb embedded in the salt. The drawn out end of the tube was connected by stout India-rubber tubing with one branch of the three-wayed tube, B, while the other was attached to the manometer, C. B was connected with a Sprengel pump fitted with an arrangement for regulating the pressure. When the pressure had been reduced by means of the pump to below 420 mm., the mercuric chloride was strongly heated by the flame of a Bunsen's burner, with the following results: Not the slightest fusion occurred, but the salt rapidly sublimed into the cooler parts of the tube, while the unvolatilized portion of the salt shrank away from the side of the tube, and clung tenaciously in the form of a solid mass to the bulb of the thermometer, which rose considerably above 300° C., the mercury shooting up to the top of the stem. After slight cooling, the air was let in, and under the increased pressure thus produced the salt attached to the bulb of the thermometer at once melted and began to boil, cracking the tube at the same time.

The experiment was next varied as follows: About the same quantity of chloride was placed in the tube as before and heated by the full flame of a Bunsen's burner. The lamp was applied during the whole of this experiment, and the size of the flame kept constant throughout. The mercuric chloride first liquefied and then boiled at 303° under ordinary pressure, and while the salt was still boiling the pressure was gradually reduced to 420 mm., when the boiling point slowly fell to 275°, at which point the mercuric chloride suddenly began to solidify, and at 270° was completely solid, the pressure then being 376 mm. When solidification was complete the pump was stopped working, but the heat still continued to the same extent as before. The salt then rose rapidly to temperatures above that at which a thermometer could be used, but not the least sign of fusion was observed. From the completion of the solidification to the end of the experiment the pressure remained at about 350 mm.

The above experiment, which was repeated three times, shows therefore that when the pressure is gradually reduced from the ordinary pressure of the atmosphere to 420 mm.,

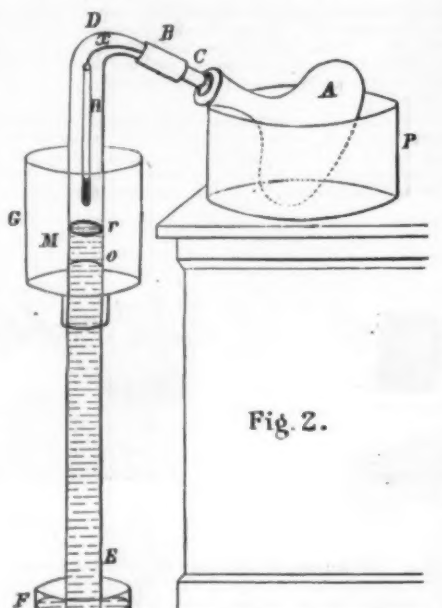


Fig. 2.

and the boiling point simultaneously from 303° to 275°, the salt solidifies while it is still boiling, notwithstanding that it is strongly heated at the same time, and that, after solidification is complete at 270°, the temperature then rises far above the ordinary boiling point (303°) of the substance without producing any signs of fusion. Under ordinary circumstances mercuric chloride melts at 288° and resolidifies at 270°–275°, *i. e.*, at a temperature identical with that at which it solidifies under diminished pressure as above described.

After the above experiments had been made the investigation had to be unavoidably deferred, and was not resumed till last autumn, when a large number of determinations were made of the boiling points of several different substances under various pressures, and from these were drawn the general conclusion described in a letter to *Nature* (vol. xxii., p. 434), in September last, viz.: "In order that any

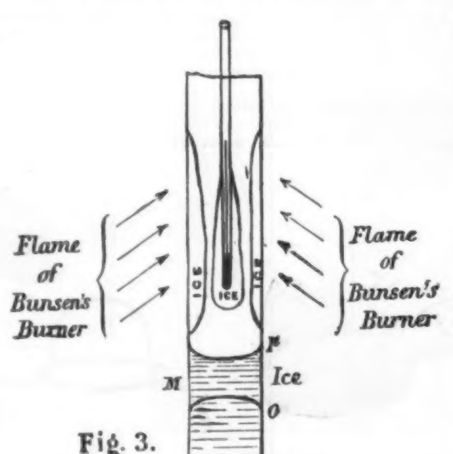


Fig. 3.

solid substance may become liquid it is necessary that the pressure be *above* a certain point, called the critical pressure, otherwise it cannot be melted, no matter how great the heat applied. "Assuming the truth of this conclusion, I set to work to apply it in the case of ice, as it would undoubtedly have the greatest interest in connection with that substance. On this account my experiments since the end of August have related almost solely to ice.

The problem to be solved was whether ice could be prevented from melting by maintaining the pressure below its critical pressure, *i. e.*, the tension of its vapor at the melting point, and that whatever the intensity of the heat applied. Now the theory of critical pressure gives us no information as to whether the ice, on non-fusion, would or would not rise above its ordinary melting point when strongly heated, but as this result had been previously attained in the case of mercuric chloride, it appeared not impossible that the ice *might* become hot.

The question as to the rise of temperature of the ice above 0°, though at first but a side issue of the investigation, became from its more especial interest the chief object of inquiry, and the experiments which have been made and those which are at present in hand relate almost solely to this point.

The great difficulty to be overcome was to maintain the pressure in the containing vessel below 4·6 mm., *i. e.*, the tension of aqueous vapor at the freezing point; for it will be easily understood that if the ice be but slightly heated the quantity of vapor given off would soon be sufficient to raise the pressure above that point. After several fruitless attempts, the following plan, involving the principle of the cryophorus, was adopted: A strong glass bottle, such as is used for freezing water by means of Carré's pump, was fitted with a cork and glass tube, C (Fig. 2), and the cork well fastened down by copper wire. A and C were then filled with wet mercury (the water facilitating the removal of the air bubbles), and C connected with the end of the tube, D E, by means of the stout India-rubber tubing, B, a thermometer having been previously attached by the wire, *x*, to the lip of the tube at B. The tube, D E, was about one inch diameter, and about four feet long from the bend to the end, E; after connection with C, it was completely filled with mercury and the whole inverted over the mercurial trough, F, as shown in the figure, when the mercury fell to 0, the ordinary height of the barometer. The mercury was run out of A by tilting up the bottle and inclining the tube, D E. By this means a Torricellian vacuum was obtained from A to O. D was next brought to the vertical, and the bottle, A, placed in the trough, P. A tin bottle, G, without a bottom was fitted with a cork, so that it might slide somewhat stiffly along D E.

To begin with, the tin bottle was placed in the position, G, and filled with a freezing mixture of salt and ice. Some boiled water was then passed up into the tube D E, sufficient to form a column at M about two inches deep. The thermometer, H, had been previously arranged so that its bulb might be one or two inches above the surface of the water, M. The bottle, A, was next surrounded by a good quantity of freezing mixture, in order that any vapor given off from the water at M might be condensed in A as fast as it was formed, and thus the internal pressure might never be more than about 1·0 to 1·5 mm. When A had been sufficiently cooled, which required about fifteen minutes, the tin vessel, G, was slid down the tube, D E, and its freezing mixture removed. The water at M had then solidified to a mass of ice, which on heating with the flame of a Bunsen's burner, melted either wholly or partially, and the liquid formed began at once to boil. The fusion commenced first at the bottom of the column of ice, whereas the upper part fused only with difficulty, and required rather a strong heat. The fusion in this case was probably due to the steam evolved from the lower portions of the ice column being imprisoned and unable to escape, and hence producing pressure sufficient to cause fusion.

When the greater part of the ice had been melted, the tube was tightly clasped by the hand, the heat of which was sufficient to produce a somewhat violent ebullition. The liquid in boiling splashed up the side of the tube and on to the bulb of the thermometer, where it froze into a solid mass, as represented in Fig. 3. By this means the ice was obtained in moderately thin layers. The tube at the points indicated by the arrows was then strongly heated by the flame of a Bunsen's burner with the following results: The ice attached to the sides of the tube at first slightly fused, because the steam evolved from the surface of the ice next the glass, being imprisoned between the latter and the overlying strata of ice, could not escape, and hence produced pressure sufficient to cause fusion, but as soon as a vent hole had been made fusion ceased, and the whole remained in the solid state, and neither the ice on the sides of the tube nor that on the bulb of the thermometer could be melted, no matter how great the heat applied, the ice merely volatilizing without previous melting; thus proving that if the pressure be maintained below the critical pressure the ice cannot be melted. In different experiments the thermometer rose to temperatures considerably above the melting and even the boiling point of water, the highest temperature reached being 180° C., when the ice had either wholly volatilized or had become detached from the bulb of the thermometer, but in no case did the ice attached to the thermometer melt when these temperatures had been reached, as erroneously stated in some reports of my experiments. The ice attached to the thermometer did not partially fuse at the commencement of the heating, because, the heat reaching the outer surface of the ice first, evaporation could take place from a free surface and the vapor not become imprisoned, as was the case with the ice attached to the sides of the tube. These experiments were repeated many times with the same result, except in one case in which the heat applied had been very strong indeed, and the ice attached to the sides of the tube fused completely. On removing the lamp, however, for a few seconds the water froze again, notwithstanding that the portion of the glass in contact with it was so hot that it could not be touched without burning the hand.

The chief conditions necessary for success appear to be (1) that the condenser, A (Fig. 2), is sufficiently large to *maintain* a good vacuum. For the size of apparatus given above it ought to be about 1 liter; (2) that the ice is not in too great mass, but arranged in thin layers. Nor must it expose too great a surface for evaporation, otherwise the steam is liable to be evolved more quickly than it can be condensed, and the pressure would therefore rise above the critical pressure. Further, in the case where the heat is applied to the under surface of the layers of ice, the latter must be sufficiently thin to allow of a vent hole being formed for the escape of the steam coming from below; if not, fusion occurs. When the heat is applied to the free surface of the ice the layers may be much thicker. In order to get the temperature to rise above the ordinary melting point of ice, it is necessary that a very strong heat be applied, otherwise all the heat is used to convert the ice into steam without raising its temperature; it must in fact be applied more quickly than it can be absorbed for changing the state of aggregation. Prof. McLeod, who has written to me to the effect that he has been unable to obtain any symptoms of hot ice, has failed, I believe, on account of not having complied with this condition. Dr. Lodge, in an admirable and very clear letter to *Nature* (vol. xxiii., p. 264), has endeavored to explain why "hot ice" is possible, and also points out the absolute necessity for supplying the heat more rapidly than it can be absorbed by the vapor.

Now the question arises, Does the thermometer in the above experiments indicate the real temperature of the ice? It has been said by Prof. Stokes that the ice, though attached to the thermometer, is not at the same temperature as the latter, and that the action is really as follows: The pressure is reduced till the boiling point falls below the melting point, and when heat is applied to ice in contact with the glass tube a film passes into vapor, and thus prevents the ice from touching the glass except at a few isolated points. The great latent heat of evaporation prevents the ice from rising to its ordinary melting point, and hence no fusion occurs. The ice is only heated—except at the few isolated

points of contact—by radiation, and therefore comparatively slowly. A portion of the heat passes through the ice and falls on the thermometer inside, and the latter rises in temperature; this causes the formation of a film of vapor between the ice and the bulb of the thermometer, so that the latter is in contact with the ice at a few points only, and therefore hardly any heat passes by conduction to the ice.

As under the circumstances of the case this appeared the most probable explanation of the phenomena, it was of great importance to show by other and more conclusive experiments whether the ice really was hot or not. For this purpose Prof. Roscoe suggested the most decisive test which could be applied, viz., dropping the supposed hot ice into water and observing the amount of heating or cooling of the latter. Up to the present I have only had the opportunity of completing two of these calorimetrical determinations, and the second of these was merely a qualitative experiment, as the weight of ice dropped in could not be found, owing to a small quantity of the water having been jerked out of the calorimeter the moment the ice entered it. In both experiments, however, the water distinctly increased in temperature, and therefore showed that the ice must have been above 80° C. In the complete experiment the weight of ice dropped into 185 grammes of water was 1·3 grammes, and the rise in temperature 0·2° C., showing that the temperature of the ice was 122° C. From the nature of the experiment the weight of ice which could be dropped into the calorimeter was only small, and though the rise in temperature was but slight, yet if the ice had been at 0° a relatively large cooling ought to have been observed. Great care was taken to avoid any error in the determinations. The thermometer employed was graduated so as to allow of a difference of 0·05° C. being easily detected, two observers read off the temperatures independently of one another, the calorimeter was inclosed in several casings and filled with the water to be used some hours before the experiment, so that it might have the temperature of the room, while the time which elapsed between the readings of the thermometer would not be more than about fifteen seconds, and finally the calorimeter was not brought into position to receive the ice till the source of heat had been removed. To place the point beyond doubt, however, several additional and perfectly satisfactory calorimetrical determinations are necessary, and if possible on a larger scale. Such experiments are at present in hand. In the meantime I would make the following remarks in favor of the high temperature of the ice. If the ice is not really hot, notwithstanding that the thermometer indicates say a temperature of 130° C., how is it possible for the ice to hang on to the thermometer? For if it be separated from the bulb by a layer of steam, it cannot hang by steam, it would at once become detached from the thermometer. The thermometer was chosen so that the bulb was of the same, and in most cases of a less diameter than the stem, so that there was nothing to prevent the ice falling away if so inclined.

In some cases I have had thin plates of ice attached by their edge at right angles to the stem of a paper scale thermometer for a considerable time without being detached or melting, notwithstanding the temperature was so high that the paper scale at that portion of the stem to which the ice clung was charred; this was the case in one of the experiments shown at the Chemical Society. In another instance I have had a thin circular piece of ice attached to the otherwise bare bulb of the thermometer, and though this piece was very thin and no more than about 2 mm. diameter, it took fully one minute or more to volatilize, notwithstanding the thermometer indicated a mean temperature of about 70° C., and the surrounding tube was very hot. If the ice were not capable of being heated above its melting point, a piece so small as that referred to would, I think, under these circumstances have fused or volatilized almost instantaneously. If the ice be really above 80° C. it ought to melt suddenly and at once on discontinuing the heat and increasing the pressure, and this I have in one or two instances found to be the case. Thus in one experiment a beautiful rod of ice nearly six inches long and about half an inch diameter was attached to a glass rod suspended in the apparatus described above and heated very strongly with a large Bunsen's burner for several minutes; the pressure was then let in, when the ice at once fell off the rod into the mercury trough below, melting completely, and as far as could be seen even before it reached the mercury. Careful observations have also been made to see whether any cavity could be detected between the ice and the hot thermometer when the latter was only partially covered with ice and indicated a high temperature, but such could not be seen either with ice or mercuric chloride. In both cases the substance appeared to rest in actual contact with the bulb of the thermometer, in this respect differing from camphor, which does exhibit such a space. I have, however, never been able to get camphor above its ordinary melting point, though by reducing the pressure below 400 mm., it solidifies while boiling, and cannot be remelted unless the pressure be increased.

One curious point about the ice experiments is the comparative slowness with which the ice appears to evaporate, though the surrounding tube is very strongly heated.

In conclusion, I need hardly say that it is highly desirable that my results should be confirmed by other observers.—*Thomas Carnelley, in Nature.*

HYDROGEN SUPEROXIDE.

Em. Schoene* recommends the use of thallium papers for estimating the "oxidizing principle" of the atmosphere, which, since the existence of ozone in the air has become doubtful, he believes to consist mainly and perhaps wholly of hydrogen dioxide. The oxidation of the thallous compounds is not dependent on the presence of moisture. Moreover, the oxidized papers can, with proper care, be preserved for any length of time and thus afford a visible record of observations made. They are best prepared by saturating, not more than two or three days before use, strips of Swedish filter paper with a solution containing in each 100 c.c. 10 grammes of thallium hydroxide, and drying as quickly as possible in the air. They are then preserved until wanted in closed vessels over burned lime. The defects of the methods of observation which depend upon the liberation of iodine from iodide of potassium (Schoenbein's and Houzeau's), are such, he thinks, as to render them wholly unfit for use. The quantity of iodine liberated depends upon the amount of moisture present, hence the "ozonometer" of Schoenbein, as can be demonstrated, is nothing but a crude hygrometer; also upon the hygroscopic condition of the materials employed in preparing the papers, hence papers obtained from different sources, though prepared in the same manner, are unequally affected when exposed together under the same conditions.

* Ber. d. deutsch. chem. Gesell. 13, 1508.

MESMERIC EXPERIMENTS.

A few physicians, among them Dr. D. B. St. John Roosa, of the State Medical Society; Dr. Mittendorf, the well-known microscopic expert; Dr. C. L. Dana, Dr. Josiah Roberts, Dr. Birdsall, Dr. Carpenter, of the County Medical Society, and others distinguished for scientific research in various departments, lately assembled in the office of Dr. George M. Beard, at No. 13 West Twenty-ninth street. The invitation proposed a private séance, recalling the wonderful stories of Anton Mesmer and his disciples, of the Count Cagliostro, and the strange narratives as to the apparent death practiced by the Hindoo fakirs collected by Dr. Esdaile, Surgeon-General of India during the first quarter of the present century, whose book was published in 1828, and of which only one copy, and that mutilated, is known to exist. The programme provided for experiments in artificially-induced trance, hypnotism, and somnambulism, with illustrations of the phenomena of catalepsy, ecstasy, rigidity, and apparent death, partial and hemi-anæsthesia, aphasia, suspension and exaltation of muscular force and of the special senses, and examples of trance speaking. The experiments were conducted upon four young men whom Dr. Beard has had under training for the last few weeks—Chas. L. Marsh, aged 16, of nervous and muscular temperament, rather narrow at the shoulders, tall for his age, in average health, but not robust; Daniel Wright, aged 25, of nervous and glandular temperament, rather imperfect muscular development, with light hair, blue eyes, and noticeable deficiency of heart and lungs; H. Scott Gray, 21 years of age, nervous and glandular temperament, light complexion and eyes, head rather small, hair sparse and of silken fineness of texture, heart and lung power rather below the average; John Wilson, of vital and muscular temperament, short and thick set, head large, shoulders large and powerful, of more than average heart power and pulmonary capacity. It would have been noticeable to the eye of an expert observer that there was a trace of what physicians style the neurotic predisposition in each of these subjects, either hereditary or acquired; but, unfortunately, Dr. Beard did not volunteer any notes on this important point, and the distinguished medical men present were left to their own conjectures. The importance of this point will be appreciated when it is recollected that, in the course of an inquiry respecting the "Etiology of Certain Phenomena called Spiritual," prosecuted some time ago by a scientific man in this city, and issued as a monograph by one of the leading publishers, the singular fact was developed, by careful inquiry, that the susceptibility to phenomena of this class, embracing self-induced and mesmeric trance, clairvoyance, etc., is invariably associated with a predisposition to nervous disturbance of the epileptic or hysterical type, and usually with a transmitted predisposition.

Dr. Beard's method of inducing trance with his subjects is simpler and less imposing than that which was employed by Mesmer and his disciples. The four subjects under experiment yesterday afternoon had been so thoroughly trained —for the susceptibility to trance increases with repetition, and with persons in the habit of using ether as a stimulant a single whiff of the drug often suffices—that a pass or two downward upon the eyelids, or even a mere contact of the finger-tips, was sufficient to put them in the condition required, while a single reverse pass dissolved the spell, and the subject recovered consciousness instantly, but not fully. On the contrary, the awakening from slumber was accompanied in nearly every instance with dazed and bewildered movements, lasting from four to ten seconds, and young Marsh complained of pains in the region of the right temple after the séance was finished.

The first series of experiments embraced suspension of the special senses—sight, smell, hearing, taste, and touch. While the subject Wright was in the trance condition the cornea of the eye, usually so sensitive to contact, could be handled with perfect impunity, and without the least movement to indicate that he was aware that any such manipulation was going on. Wright's eyes are naturally rather weak, and the retina is extremely sensitive to light—painfully so, in fact. This point was first shown by throwing a powerful beam from the ophthalmoscope mirror into the eye, when the pupil could be seen to contract, and the utmost self-control was required on the part of the subject to prevent involuntary closure of the lids. The right and left orbs were equally sensitive in this particular. Dr. Beard now advanced to the patient, executed a pass or two, and requested him to look at some angels coming through the ceiling at an angle of about 45 degrees. There was no alteration in the pulse or respiration of the subject as the trance supervened; it was preceded by no pallor and no perceptible muscular tremor. Both eyes were still open, and Wright was gazing with wild intensity at the angels, when, with a well-adjusted light, a powerful beam from the ophthalmoscopic mirror was projected directly upon the retina. The pencil, concentrated by a mirror three inches in diameter, was so intense that its blaze was visible as a luminous spot within the eye, notwithstanding the fact that the apartment was not darkened for the experiment, and was consequently flooded with full daylight. The beam might as well have been directed upon the unclosed eye of a cadaver in its coffin, as far as any sensibility was concerned. Winking was suspended, and, although the beam fell suddenly upon a retina abnormally sensitive under ordinary conditions, not the slightest instinctive tremor of the eyelid or contraction of the pupil betrayed its presence. When the left had been tested in the same manner, with the same result, Dr. Mittendorf handed the instrument to one of the medical experts standing by, who, after repeating the test, expressed himself satisfied as to its decisiveness, as the contraction of the pupil under a sudden access of light is an involuntary act, and one that cannot be restrained by effort of the will. In a similar manner the subjects were rendered color-blind.

The tests as to the senses of smell and taste were very simple in their description, and consisted in the use of such powerful agents as ammonia and red pepper, which were endured without the least sign of perception of their presence. An interesting experiment with Gray, to illustrate the possibility of sharply circumscribed anæsthesia, will serve as an example of the class of tests which were employed in reference to the sense of touch. In the trance condition sensibility was suspended in the thumb of the right hand, over a sharply defined area, embracing the ball and the internal surface. The latter was tested with needles and pins, by compression with the forceps, etc., without producing a trace of reflex action, while the instant the point of the needle was applied a hair's breadth beyond the area marked out for insensibility, young Gray, whose susceptibility to pain is naturally of the most exalted order, was unable to control the involuntary reflex movement of the hand. The tests for suspension of hearing were in their nature rather less satisfactory than those for suspension of the other four, consisting of loud or shrill sounds suddenly applied. The abolition of the sense was, however, conceded by the experts present, after every ingenious method of determination that could be suggested by trained experimentalists had been exhausted.

In the meantime a number of the party, with Gray and Wilson, had adjourned to the main office, where a singular series of tests was in progress. Both are young men of no literary culture, and, in their normal condition, incapable of protracted oratorical effort. Gray was directed to address the audience with an impromptu encomium of Gen. Garfield, and Wilson with an analogous eulogium of Hancock. It was amusing to see the two orators, standing side by side, each pouring forth at the top of his voice a torrent of complimentary polysyllables, not one word of which could he have defined without appealing to the dictionary. "I will now," said the experimentalist, after he had set both going simultaneously, "show you a most singular phenomenon," and he struck a slight, percussive blow upon the neck of Gray, near the tip of the left ear. The effect was instantaneous—extraordinary. In the very middle of a syllable his power of articulation was suspended, and he stood as motionless and silent as a statue. After some three minutes had passed, Dr. Beard gave the motionless man a slight slip on the back, in the dorsal region of the spinal column. Instantaneously the organs of articulation were in motion again, and, taking up the broken syllable at the exact point where it was interrupted by the touch upon the neck in the region of the ear, the orator went on to expatiate upon the virtues of Garfield. This experiment—so curious and suggestive in its aspects—was repeated several times, first with Gray, then with Wilson, and *vice versa*; but Dr. Beard did not volunteer any theoretical explanation. Perhaps the most extraordinary experiment of all was the production of an artificial attack of catalepsy in the case of Wilson. In this condition his body was so rigid that two of the medical men present lifted him in a horizontal position by taking hold of his head and feet, without producing any flexure of the spinal column or bending at the hips. He was placed at an angle against the wall, and stayed as motionless as a piece of timber until he was removed. He was pricked with pins; the pupil of the eye was tested with concentrated light. Not the least trace of any muscular or other movement was elicited by these experiments; nor was there any person present whose muscular power was equal to the task of flexing the arm at the elbow or wrist, or even of bending one of the rigid fingers.

As a last experiment, Dr. Beard transformed Gray and Wilson into a pair of Maine "jumpers," and illustrated the phenomena by tests.—*N. Y. Times, Jan. 7.*

SOME PRACTICAL HINTS TO RECENT GRADUATES.

By Boardman Reed, M.D.

These hints are offered to young practitioners by one who can still remember when he was young himself. The very wise will not find them edifying, and will therefore please skip them.

Of course when you go forth surcharged with all that is newest and best in the science of medicine, you go full of enthusiasm, confidence, and hope. When you locate and hang up your brand-new diploma, you will feel a proper superiority over the old fogy practitioners of your neighborhood. As for the old women, who will occasionally have the effrontery to suggest to you a different line of treatment for some critical case, you will wither them with a scornful look as you inform them that having graduated at a first-class medical college you are supposed to understand your business. It is necessary that you should maintain your dignity, but meanwhile make a mental note of all the suggestions you receive from these humble sources and ponder over them. They are sometimes valuable. When an officious nurse removes your regulation flaxseed-meal poultice from a threatening case of pneumonia and substitutes an onion poultice, snub her effectually for daring to change your treatment without consulting you; but if you find the patient's strength rallying and the disease yielding in consequence, as you sometimes may, tell her she need not take the trouble to change back again, now that the onions are on.

You will probably be surprised to learn how many good things some of the old women know which your instructors somehow forgot to tell you about. There is so much to teach nowadays, that after a short two or three years' course there will always be a good deal left over to be learned from the nurses and old women.

The old-fashioned doctors you may find awfully rusty in anatomy, disgustingly ignorant about grammes, cubic centimeters, and such things, and hopelessly bewildered when you use the new chemical nomenclature in speaking to them of their old pharmaceutical friends. They may even betray a shocking ignorance of the microscopic appearance of the cells in the mammary tumors which they have been carving out for twenty-five years past. Yet if they offer to give you a pet prescription for colic or lumbago, which they say they have found can be depended on, just jot it down in your note-book, even if you feel called upon to protest that you are already brimful of knowledge concerning the most modern treatment of that very disease. Some time you may find that prescription a perfect godsend.

In short, don't be above learning from anybody. Keep up your dignity, but keep your eyes and ears open.

Remember that while the older physicians around you will have the advantage of you in experience, you will have a corresponding advantage over them in the greater amount of time and thought you can devote to each case. The experienced practitioner may be the possessor of a gigantic intellect and may have accumulated a vast fund of very valuable medical knowledge, but if he sees sixty patients a day, each patient must be content with visits of a very few minutes' duration, and with only a sixtieth part of the time and study which he devotes to the consideration of his cases after returning home. On the other hand, if you are so unfortunate as to be obliged to concentrate all your energies upon a single case for the first few weeks of your practice, the patient will be fortunate in the possibility of receiving an abundance of attention and of being cured in the most rapid and brilliant manner. If you make the most of your opportunities you may in this way score numerous points (especially among the poor), making cures of bad cases which your older rivals could not afford to devote sufficient attention to and therefore had failed to relieve. Thus you may lay the foundations of a reputation, and reputation is money.

Yet do not be deceived by any of these brilliant achievements of yours into undervaluing experience. It is simply invaluable, and in order to acquire it as fast as possible you will do well to accept all the practice you can honorably

obtain, whether it brings you any money at first or not. When I began practice I esteemed so highly the privilege of treating a difficult case that I often felt like tendering payment instead of demanding it from the patient.

Don't tell your patients what medicine you are giving them. This is a rule to which there ought to be but few exceptions. Doctors and druggists are the most difficult of all patients to treat, simply because they know what they are taking. When you are called upon to prescribe for a chronic invalid or hypochondriac who has taken everything, knows at least by name all the drugs in the Pharmacopœia, and insists upon being told what each prescription contains, your task becomes most arduous. You cannot hope as a rule to do him (or more often it is *her*) any good unless you can prevent such a curiosity from being gratified. It is in just such cases that a knowledge of the new remedies may stand you in good stead.

But while yourself observing a prudent reticence be careful to learn from your patients as much as possible. Encourage them to state fully all about their idosyncrasies in regard to medicines. Most of these will be imaginary, but some of them may be real. You need not necessarily discard a valuable remedy because it has once disagreed. Often reducing the dose is all that is necessary to secure excellent results.

When a messenger comes out of breath to summon you to see a dying woman, go at once, but if it is in the country or at night anywhere, take along some valerian or assafœtida as well as some nitrite of amyl. For nine times out of ten it will be a case of hysterics. The nitrite will prove just the thing when the attack takes the form of convulsions, whether hysterical, epileptic, or only simulated, though it would be inappropriate of course if there were cerebral congestion or a tendency to apoplexy as shown by a flushed face and throbbing carotids. If it be hysterics the nitrite inhaled from a napkin usually acts very promptly. If it should be epilepsy the same remedy may do good, especially if there is a tendency to run into the *status epilepticus*; and if it be only shamming, nothing so disgusts and frightens the malingerer. Such a short cut to diagnosis and treatment may not have been mentioned by your professors in their lectures, since it is their duty to inculcate more scientific methods. Still, you will find such an empirical procedure exceedingly convenient in some cases where you will scarcely have time to employ the sphygmograph, ophthalmoscope, and æsthesiometer in order to make a careful and thoroughly reliable diagnosis.

When you have diagnosticated hysterics it will usually be safer not to announce this fact to the patient or her friends in so many words, unless she happens to be the servant girl. In that case you may venture to name the disease boldly and to prescribe the most efficient treatment, which is an effusion of cold water repeated occasionally until a cure is effected. When the patient is a lady, call her malady a nervous shock, a sympathetic disturbance, or an eccentric manifestation of neurasthenia, or anything else you like, but don't call it hysterics. The word is apt to be considered objectionable.

Join one or more good medical societies and become an active working member. It will pay you well in the end. Respect the etiquette and ethics of the profession. This may seem to necessitate the loss of a good paying family now and then, but will be the most profitable course in the long run. Even the ignorant masses, with all their weakness for running after quacks and quack medicines, have a greater respect for the physician who is a high-toned gentleman.

Stick close to your business and study hard. Study your books and the journals and your cases, making full notes of the latter for future reference whether you intend to write them up for publication or not. It will render you more careful and exact.

Above all, don't meddle with politics nor with neighborhood quarrels. Don't gossip nor hang around drinking places. Attend church regularly on Sunday, but religiously abstain from taking sides in church dissensions. You will never get to heaven nor into practice by making yourself an active partisan in any such troubles.—*Medical Bulletin.*

THE USE OF TEST-PAPER IN DISEASE.

By W. H. BENTLEY, M.D., LL.D., Valley Oak, Ky.

FOR several years I have been convinced that test-paper is too little used by physicians, especially country practitioners, in determining the characteristics of the excreta in disease. The following cases will illustrate:

A few years since, I resided in the village of M——. There were three other physicians there resident at the time. We were all on terms of great intimacy.

During the summer and early autumn there had prevailed an epidemic of diarrhea among children of four or five years, and under, with acid discharges. For this I had prescribed with unvarying success, a mixture of prepared chalk, bicarb. soda, pulverized bayberry, gum arabic, white sugar, and cinnamon water.

In October I was summoned, as a medical expert, to attend a felony trial, in an adjoining county, in which the plea of insanity was interposed.

Just as I was leaving, a lady applied to me to prescribe for her four-year-old child, who was suffering from diarrhea. The child was not present, but I naturally supposed that she had the disease in the prevailing form. I prescribed the chalk mixture already referred to, and departed. I was absent for six days. On my way home I met a dispatch urging my speedy return, as my "little patient was at the point of death." On my arrival I found her extremely ill, the bowels discharging nearly every 30 minutes. The three physicians were all present, and hurriedly detailed their various lines of treatment. They embraced nearly every alkaline and vegetable remedy known to have been prescribed in similar cases.

I at once tested the alvine evacuations, and found them *intensely* alkaline. I prescribed acetic acid in 5 minim doses, to be repeated every three or four hours. Improvement was immediate, and complete recovery rapid.

Another case in point was that of J. W., a recently married man, at 28. He had, up to the present attack, enjoyed uninterrupted, life-long health. Three weeks previous to my visit to him, he had a violent attack of enteric fever. He called a physician whose skill was thoroughly baffled during the first ten days, that he called for counsel.

He obtained the aid of two very able physicians, but the case lingered, and the bowels could not be controlled at any one time for a period of more than six or eight hours. Happening to visit a case in the vicinity, I was invited to a conference with the three medical gentlemen already in attendance. I learned that the "acid treatment" had been early installed in the case, and regularly maintained. It occurred to me to test the evacuations, which I did, and to my surprise I found them extremely acid.

Five grain doses of bicarb. soda in solution, every four hours, controlled the bowels in ten or twelve hours, and the patient made a rapid and complete recovery.

In this latter case the acidity of the alvine discharges struck me as being somewhat remarkable, as in every case of enteric fever, in which I had ever tested the discharges from either bladder or bowels, I had found alkaline reactions.

I think that death would have supervened in both of the above cases had the original lines of treatment been maintained, and I mention them ɪ ɴ ther prominent cases in my own practice, in which the "litmus paper" has served me a good turn. Its use is common enough in urinary tests, but I do think that a majority of country and village physicians neglect its use too much in other affections.—*Medical Summary.*

BAMBOO.

THE United States Consul-general at Shanghai, China, writes that there is, perhaps, nothing in China which supplies more of the primary wants of the people of that empire than the bamboo. It is applied to so many different uses that it is no easy task to enumerate them all. The list is said, however, to number at least 500 purposes wherein this plant is made to serve these industrious and economical people. Frequently it is made to take the place of both iron and steel. The farmer builds his house and fences out of it; his farming utensils, as well as his household furniture, are manufactured from it, while the tender shoots furnish him with a most delicious vegetable for his table.

The roots are carved into fantastic images, into divining-blocks to guess the will of the gods, or cut into lantern handles and canes. The tapering culms are used for all purposes that poles can be applied to, in carrying, supporting, propelling, and measuring, for the props of houses and frameworks of awnings, for ribs of sails and shafts of rakes, for fences and every sort of frames, coops, and cages, the wattles of abattis, the handles and ribs of umbrellas and fans. The leaves are sewed into rain-cloaks and thatches, plaited into immense umbrellas to screen the huckster and his wares on the stall, or into coverings for theaters and sheds. The wood, cut into splints of various sizes, is woven into baskets of every form and fancy, sewed into window curtains and door screens, plaited into awnings, and twisted into cables. The shavings and curled threads furnish materials for stuffing pillows, while other parts supply the bed for sleeping, the chopsticks for eating, the pipe for smoking, and the broom for sweeping; the mattress to lie upon, the chair to sit upon, the table to eat on, the food to eat, and the fuel to cook it with are also derived from it; the ferrule to govern with, and the book to study from; the tapering plectrum for the lyre, and the reed pipe of the *sang* or organ; the shaft of the soldier's spear, and the dreaded instrument of the judge; the skewer to pin the hair, and the hat to screen the head; the paper to write on, the pencil to write with, and the cup to put the pencil in; the rule to measure length, the cup to gauge quantities, and the bucket to draw water; the bird cage, the crab-net, and the fish-pole are one and all furnished by this plant, whose beauty when growing is commensurate to its usefulness when cut down. A score or two of bamboo poles for joists and rafters, fifty fathoms of rattan ropes, and a supply of palm leaves and bamboo mats for a roof, supply material for a common hut in the south of China; $5 will build a decent one. It not only furnishes the poor and laboring classes with necessaries, but it supplies the richer classes with many of their luxuries, besides many articles of furniture now being made which contribute so much to the comfort of foreigners, are manufactured wholly or in part from this plant, while its shoots are cut into slices, sun-dried and pickled.

In that portion of the entire south of the Yangtze there are said to be growing about eighty varieties of the bamboo; of this number, however, only five or six are drawn upon to furnish the enormous yearly demand for consumption. At Foochow and Swataw the large size grows to the height of forty to fifty feet, and in diameter six or seven inches. The largest variety I have seen growing is found on the island of Formosa; its height is from fifty to sixty feet, while its diameter is seven to eight inches. It is the shoots from the large variety which are so eagerly sought after for the table. The stalk, however, is said not to be so useful as that of the smaller variety, as it is neither so tough nor durable as the latter. I have been induced to make these remarks in the hope that our government might favorably consider the advisability of introducing this plant into the Southern States, and such other localities as are suitable to its growth. I am confident that the benefits which would result to the country from such a course would in a few years be perceptibly felt, for a plant which has served a people so long and well as the bamboo has the Chinese, will certainly, under American genius, soon expand its already broad field of usefulness. From a small grove on a plantation or farm a variety of purposes could be subserved during the year, for it frequently happens that the farmer has occasion to use just such a sized pole or piece of timber as can be found in any such grove. Supplied with such a plant, he would only have to select the size needed, cut it off, and it is ready for use, and the following year will find it replaced by at least two others. The only difficulty is in rooting it; after this is once successfully accomplished, however, it cares for itself. The expenses attending such an experiment will be more than can reasonably be expected to be borne by private enterprise. Upon this point I speak from experience, for a few days ago a vessel cleared for Oregon, the Otago, Captain Boyd in command. By this vessel I sent twelve boxes of bamboos for transplanting, and although, through the kindness of the captain, I had no freight to pay, yet the collecting, boxing, and getting them on board was a considerable tax. Good varieties of the bamboo are grown in Japan and Brazil, as well as in China; but, all things being considered—labor, accessibility, etc.—the experiment of introduction could be tried, perhaps, with less expense from China than from any other country.

WASHINGS FROM ROADS.

THE washings from the public roads that accumulate in ditches and pools into which they lead, contain a very large amount of fertilizing material. They contain, among other valuable materials, the solid and liquid droppings of animals, the foliage and stalks of plants, the leaves of trees, and earth of various sorts that has been reduced to a great degree of fineness by the feet of animals and the wheels of carriages. The value of the first-named substances is acknowledged by all farmers. Many are unacquainted with the use of finely pulverized earth, but those who have employed it speak of it in the highest terms. The sweepings of the streets of most European cities and towns are disposed of for more than enough to pay for collecting them. They are difficult to handle as they are liable to be blown about by the wind. When applied as topdressing to grass land they produce remarkably good results. The like is true of their use on grain fields. The loose materials on roadbeds are carried by rains into ditches where they accumulate or are conveyed, if the land is descending, into hollows. There they accumulate, and after the water has passed out of them by drainage or evaporation, they assume a compact form. The consistency of the material allows it to be lifted by the shovel into carts very readily. It may be spread over grass land where it will disintegrate by the action of rain; or it may be applied to soil that is devoted to any cultivated crops. The value of finely pulverized soil as a fertilizer is admitted by all who have experimented with it, and its employment will be general in the agriculture of the future.—*Chicago Times.*

LIME ON LAWNS.

PULVERIZED fresh lime, a correspondent of the *Gardener's Chronicle* says, will effectually drive earth worms from lawns. The lime also kills moss, which is so troublesome on old lawns, often destroying large patches of grass, and so sadly interfering with mowing. Mix the lime with twice its bulk of fine soil. Leached wood-ashes we have found better than soil for mixing with lime.

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